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Volume 29 No. 3 March 2020

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Editor : Anil Ahlawat

CHEMISTRY MUSING

PROBLEM SET 80

Chemistry Musing was started from August '13 issue of Chemistry Today. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / NEET with additional study material.

In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / NEET. The detailed solutions of these problems will be published in next issue of Chemistry Today.

The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue. We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

JEE MAIN/NEET

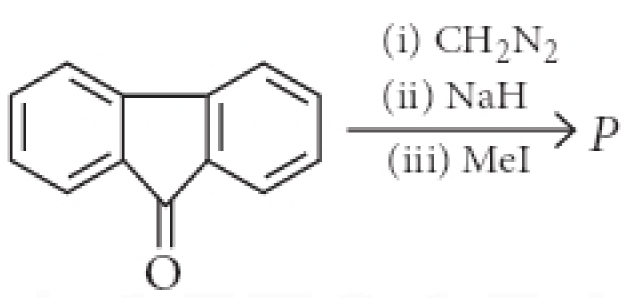
1. Which of the following complexes is optically inactive but its other geometrical isomers is optically active?

(a) *trans*-Dicyano*bis*(ethylenediamine)cobalt(III) nitrate

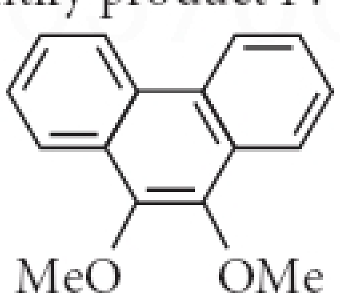
(b) *mer*-Triamminetrichloridoplatinum(IV) chloride

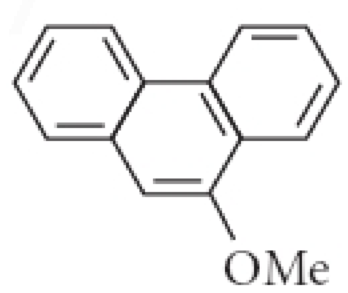
(c) *cis*-Diamminedinitrito-O-platinum(II)

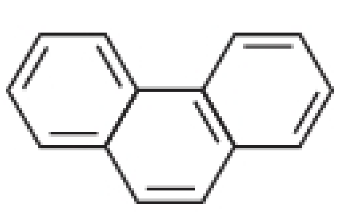
(d) *trans*-Tetraamminedichloridocobalt(III) bromide

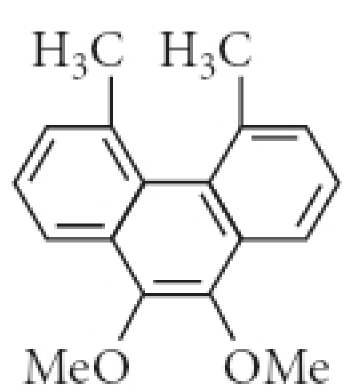
2. 

Identify product *P*.

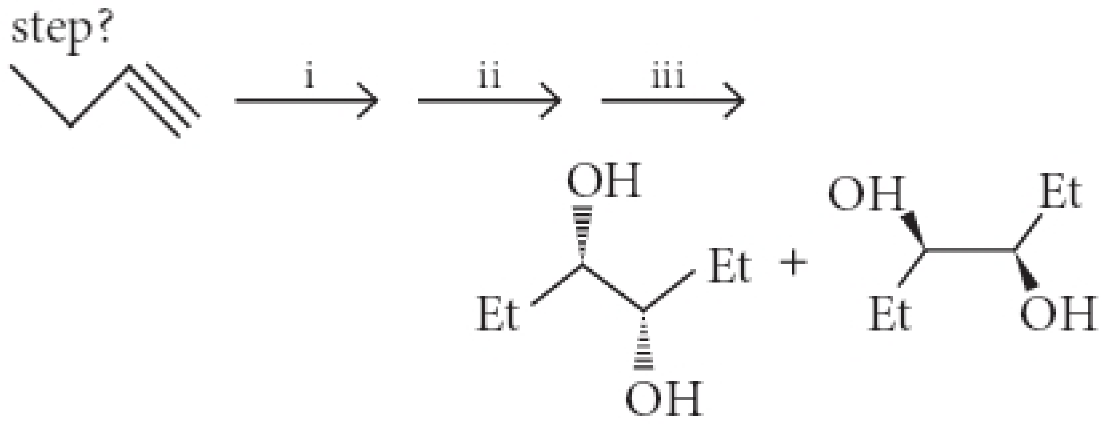
(a) 

(b) 

(c) 

(d) 

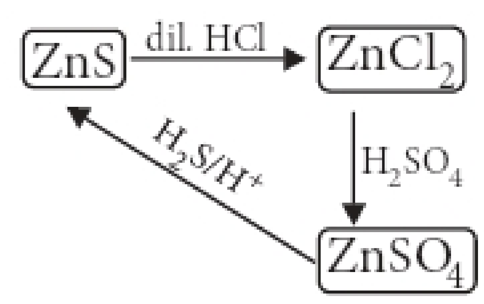
3. The following transformation is carried out in three steps. What is the appropriate reagent for the first step?

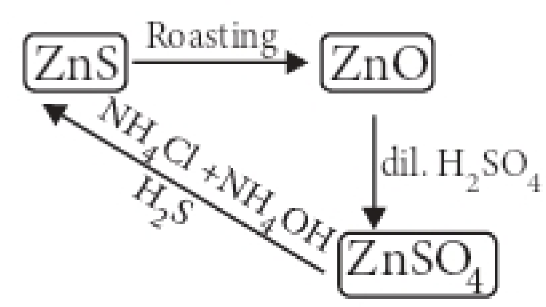


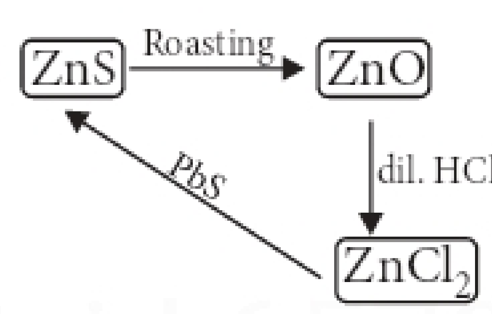
(a) H_2/Lindlar's catalyst (b) $C_2H_2/NaNH_2/CH_3I$

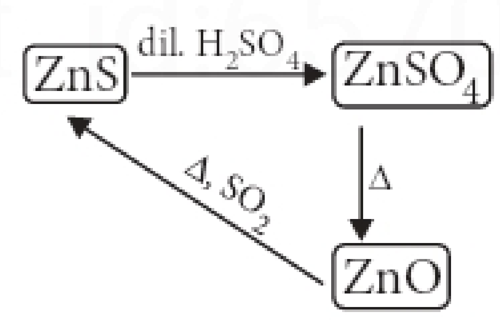
(c) $NaNH_2$/Et-I (d) H_2/Pd/C

4. Which diagram shows correct set of reactions for ZnS ?

(a) 

(b) 

(c) 

(d) 

5. 1 g of a mixture containing NaCl and $CaCl_2$ is dissolved in water. Sodium oxalate on addition to this solution completely converts $CaCl_2$ to CaC_2O_4. The CaC_2O_4 is filtered and dissolved in dil. H_2SO_4. The clear solution requires 22 mL of 0.1 M $KMnO_4$. What will be the freezing point of an aqueous solution prepared by dissolving 5 g of same mixture containing $CaCl_2$ and NaCl in 100 g water. K_f of water is 1.86 K kg^{-1} mole^{-1}. Assume complete dissociation of $CaCl_2$ and NaCl.

(a) 378.23 K (b) 290.3 K

(c) 270.23 K (d) 390.3 K

JEE ADVANCED

6. In the iodometric estimation in the laboratory which process(es) is/are involved?

(a) $Cr_2O_7^{2-} + H^+ + I^- \rightarrow 2Cr^{3+} + I_2$;
$I_2 + S_2O_3^{2-} \rightarrow S_4O_6^{2-} + I^-$

(b) $MnO_4^- + H^+ + I^- \rightarrow Mn^{2+} + I_2$;
$I_2 + S_2O_3^- \rightarrow S_4O_6^{2-} + I^-$

(c) $MnO_4^- + OH^- + I^- \rightarrow MnO_2 + I_2$;
$I_2 + S_2O_3^{2-} \rightarrow S_4O_6^{2-} + I^-$

(d) $Cr_2O_7^{2-} + OH^- + I^- \rightarrow 2Cr^{3+} + I_2$;
$I_2 + S_2O_3^{2-} \rightarrow S_4O_6^{2-} + I^-$

COMPREHENSION

0.16 g of methane was subjected to combustion at 27 °C in a bomb calorimeter. The temperature of the calorimeter system (including water) was found to rise by 0.5 °C. The thermal capacity of the calorimeter system is 17.7 kJ K^{-1}.

7. The heat of combustion of methane at constant volume is
(a) 885 kJ mol^{-1} (b) −885 kJ mol^{-1}
(c) 889.98 kJ mol^{-1} (d) −889.98 kJ mol^{-1}.

8. The heat of combustion of methane at constant pressure is
(a) −889.98 kJ mol^{-1} (b) 889.98 kJ mol^{-1}
(c) −880.91 kJ mol^{-1} (d) 880.91 kJ mol^{-1}

NUMERICAL VALUE

9. In a compound C, H and N are present in 9 : 1 : 3.5 by weight. If molecular weight of the compound is 108, the number of H-atoms present in the molecular formula will be______.

10. Following are the two first order reactions with their half-lives given at 25°C,

$$A \xrightarrow{t_{1/2} = 30 \text{ min.}} \text{Products}$$

$$B \xrightarrow{t_{1/2} = 40 \text{ min.}} \text{Products}$$

The temperature coefficients of their reaction rates are 3 and 2, respectively, between 25 °C and 35 °C. If the above two reactions are carried out taking 0.4 M of each reactant but at different temperature 25 °C for the first order reaction and 35 °C for the second order reaction, then the sum of ratio of the concentrations of A and B after an hour is ______.

UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I		Column II
1. SOFELPIORNAVT	(a)	A device which involves laser principle but produces microwave radiaton.
2. ESGLOIGDNAIS	(b)	It is a disease caused by the deficiency of vitamin D.
3. ASMRE	(c)	The suberylarginine ester of a steroid isolated from toad venom.
4. TRIOMOOLELMNTNI	(d)	A substance used for killing the worm-like species.
5. LEACSAOMIAOT	(e)	A group of proteins containing flavin in prosthetic groups. It is important in electron transport in biological systems.
6. ZRGHIRNISADE	(f)	It is a substance obtained from enzyme lecithinase of snake venom on lecithin.
7. TEPMIHANEAM	(g)	It refers to a clay mineral containing phyllosilicate. It is a very soft phyllosilicate group of minerals that form when they precipitate from water solution as copic crystals.
8. CYEOHNLISTLI	(h)	It is a drug used in the form of a sulphate which stimulates the central nervous system when administered in cases of depression.
9. NOEMDAECIT	(i)	Glycosphingolipids composed of sphingosine, fatty-acid, at least one sugar and sialic acid. Found in brain, nervous tissues and erythrocytes.
10. OUTBIXFON	(j)	It is method of plating iron or steel with zinc to form a corrosion-resistant coating. It involves zinc diffusion process in which the iron is heated in contact with zinc powder.

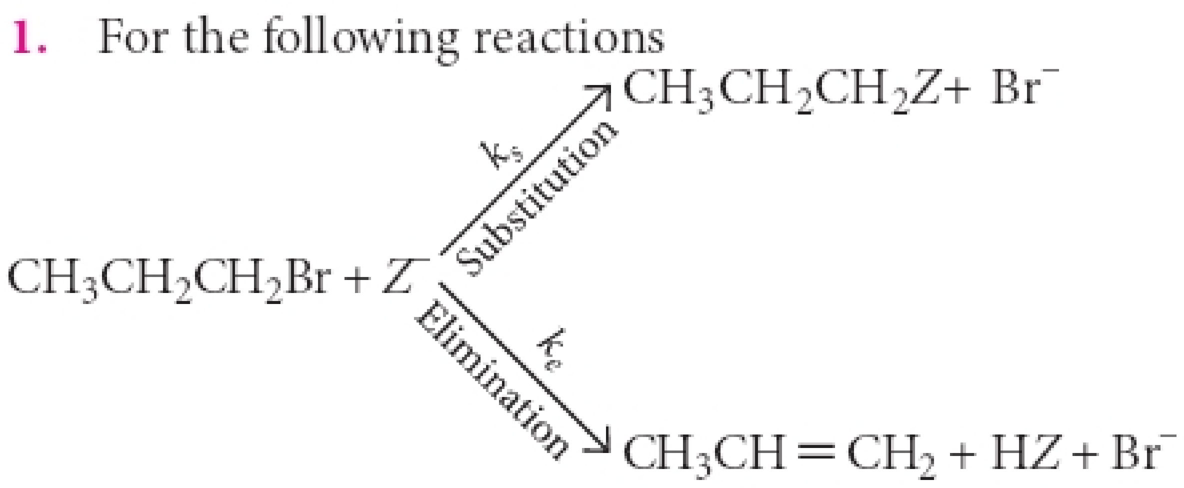
Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Names of solution senders will be published in next issue.

SOLVED PAPER

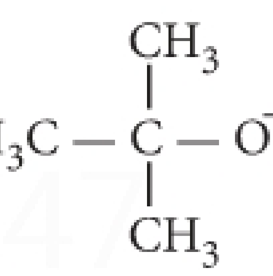
Held on 7th Jan, Evening Shift

JEE MAIN 2020

1. For the following reactions



where,

$Z^- = CH_3CH_2\bar{O}$ (A) or  (B),

k_s and k_e, are, respectively, the rate constants for substitution and elimination, and $\mu = \frac{k_s}{k_e}$, the correct option is

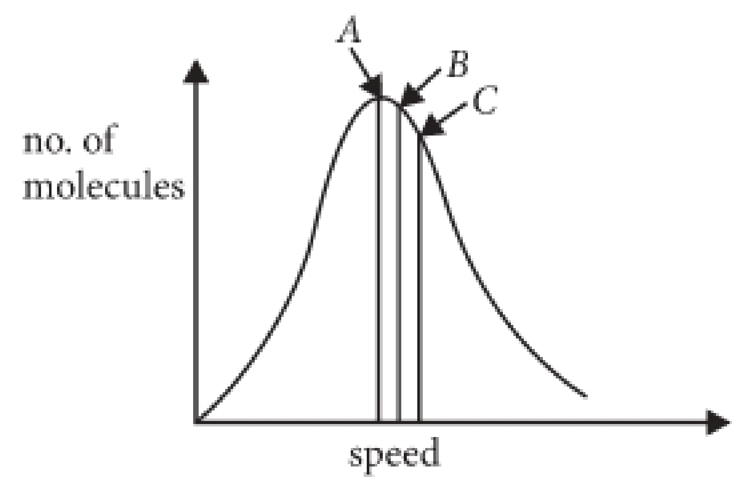
(a) $\mu_B > \mu_A$ and $k_e(A) > k_e(B)$
(b) $\mu_B > \mu_A$ and $k_e(B) > k_e(A)$
(c) $\mu_A > \mu_B$ and $k_e(B) > k_e(A)$
(d) $\mu_A > \mu_B$ and $k_e(A) > k_e(B)$

2. Among statements (A)–(D), the correct ones are

(A) Decomposition of hydrogen peroxide gives dioxygen.
(B) Like hydrogen peroxide, compounds, such as $KClO_3$, $Pb(NO_3)_2$ and $NaNO_3$ when heated liberate dioxygen.
(C) 2-Ethylanthraquinone is useful for the industrial preparation of hydrogen peroxide.
(D) Hydrogen peroxide is used for the manufacture of sodium perborate.

(a) (A), (C) and (D) only
(b) (A), (B) and (C) only
(c) (A) and (C) only
(d) (A), (B), (C) and (D)

3. Identify the correct labels of A, B and C in the following graph from the options given below



Root mean square speed (V_{rms}); most probable speed (V_{mp}); Average speed (V_{av})

(a) A-V_{av}; B-V_{rms}; C-V_{mp}
(b) A-V_{rms}; B-V_{mp}; C-V_{av}
(c) A-V_{mp}; B-V_{rms}; C-V_{av}
(d) A-V_{mp}; B-V_{av}; C-V_{rms}

4. In the following reactions, products (A) and (B), respectively, are

$\underset{\text{(hot and conc.)}}{NaOH} + Cl_2 \longrightarrow (A) + \text{side products}$

$\underset{\text{(dry)}}{Ca(OH)_2} + Cl_2 \longrightarrow (B) + \text{side products}$

(a) $NaClO_3$ and $Ca(ClO_3)_2$
(b) $NaOCl$ and $Ca(ClO_3)_2$
(c) $NaClO_3$ and $Ca(OCl)_2$
(d) $NaOCl$ and $Ca(OCl)_2$

5. The redox reaction among the following is

(a) combination of dinitrogen with dioxygen at 2000 K
(b) formation of ozone from atmospheric oxygen in the presence of sunlight
(c) reaction of H_2SO_4 with NaOH
(d) reaction of $[Co(H_2O)_6]Cl_3$ with $AgNO_3$.

6. Which of the following statements is correct?

(a) Gluconic acid is obtained by oxidation of glucose with HNO_3.
(b) Gluconic acid is a dicarboxylic acid.
(c) Gluconic acid can form cyclic (acetal/hemiacetal) structure.
(d) Gluconic acid is a partial oxidation product of glucose.

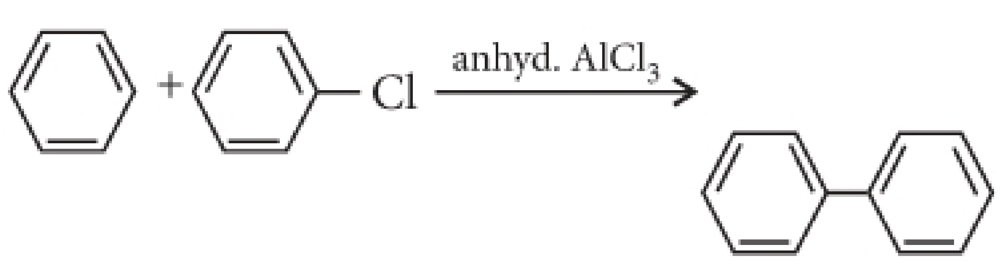
7. Two open beakers one containing a solvent and the other containing a mixture of that solvent with a non-volatile solute are together sealed in a container. Over time
(a) the volume of the solution increases and the volume of the solvent decreases
(b) the volume of solution and the solvent does not change
(c) the volume of the solution does not change and the volume of the solvent decreases
(d) the volume of the solution decreases and the volume of the solvent increases.

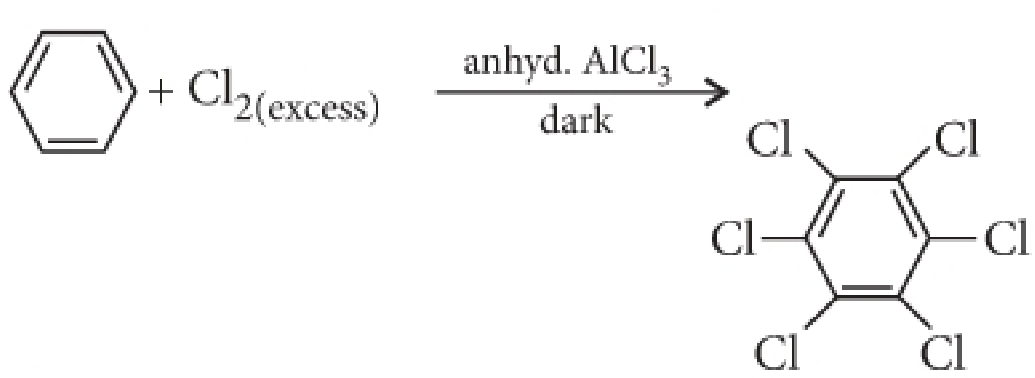
8. The number of possible optical isomers for the complexes MA_2B_2 with sp^3 and dsp^2 hybridised metal atom, respectively, is
Note: *A* and *B* are unidentate neutral and unidentate monoanionic ligands, respectively.
(a) 2 and 2 (b) 0 and 1 (c) 0 and 0 (d) 0 and 2

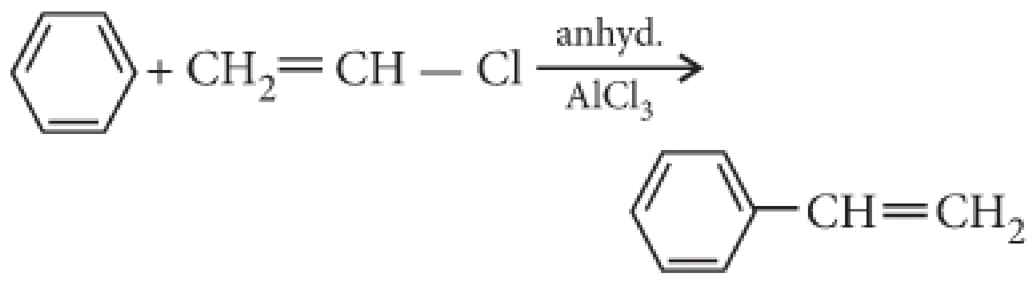
9. Within each pair of elements F and Cl, S and Se, and Li and Na, respectively, the elements that release more energy upon an electron gain are
(a) Cl, Se and Na (b) Cl, S and Li
(c) F, S and Li (d) F, Se and Na

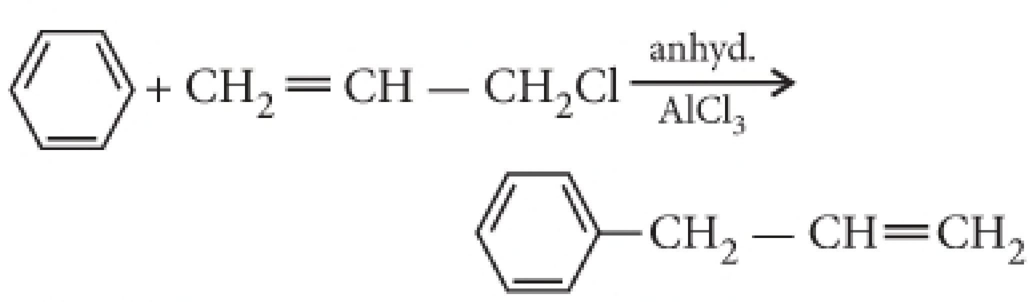
10. The refining method used when the metal and the impurities have low and high melting temperatures, respectively, is
(a) distillation (b) liquation
(c) zone refining (d) vapour phase refining.

11. Consider the following reactions.

(A) 

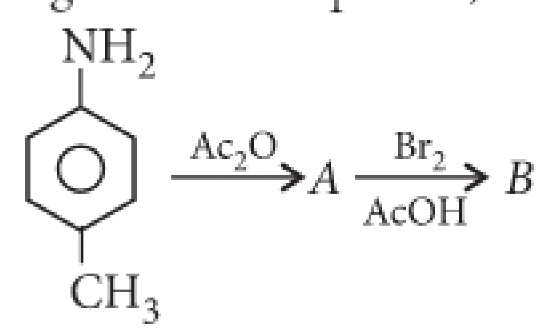
(B) 

(C) 

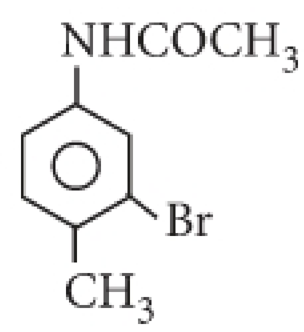
(D) 

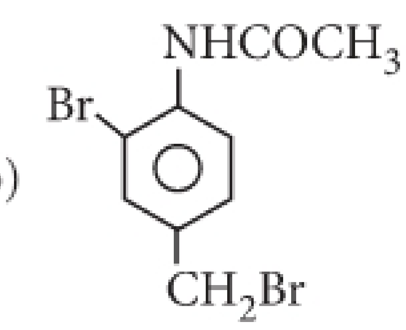
Which of these reactions are possible?
(a) (A) and (B) (b) (B) and (D)
(c) (A) and (D) (d) (B), (C) and (D)

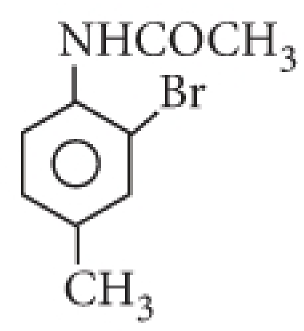
12. In the following reaction sequence,

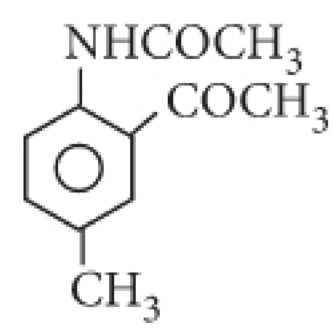


the major product *B* is

(a) 

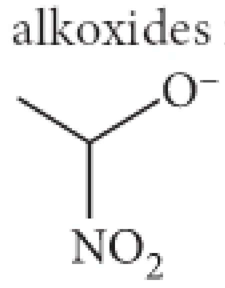
(b) 

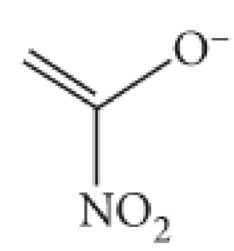
(c) 

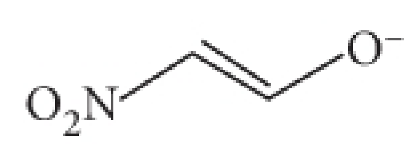
(d) 

13. The equation that is incorrect is
(a) $(\Lambda_m^\circ)_{H_2O} = (\Lambda_m^\circ)_{HCl} + (\Lambda_m^\circ)_{NaOH} - (\Lambda_m^\circ)_{NaCl}$
(b) $(\Lambda_m^\circ)_{NaBr} - (\Lambda_m^\circ)_{NaI} = (\Lambda_m^\circ)_{KBr} - (\Lambda_m^\circ)_{NaBr}$
(c) $(\Lambda_m^\circ)_{NaBr} - (\Lambda_m^\circ)_{NaCl} = (\Lambda_m^\circ)_{KBr} - (\Lambda_m^\circ)_{KCl}$
(d) $(\Lambda_m^\circ)_{KCl} - (\Lambda_m^\circ)_{NaCl} = (\Lambda_m^\circ)_{KBr} - (\Lambda_m^\circ)_{NaBr}$

14. The correct order of stability for the following alkoxides is


(*A*)


(*B*)


(*C*)

(a) (*C*) > (*B*) > (*A*) (b) (*B*) > (*A*) > (*C*)
(c) (*B*) > (*C*) >(*A*) (d) (*C*) > (*A*) > (*B*).

15. A chromatography column, packed with silica gel as stationary phase, was used to separate a mixture of compounds consisting of (*A*) benzanilide, (*B*) aniline and (*C*) acetophenone. When the column is eluted with a mixture of solvents, hexane :

ethyl acetate (20 : 80), the sequence of obtained compounds is

(a) (*B*), (*A*) and (*C*) (b) (*A*), (*B*) and (*C*)
(c) (*B*), (*C*) and (*A*) (d) (*C*), (*A*) and (*B*)

16. The bond order and the magnetic characteristic of CN^- are

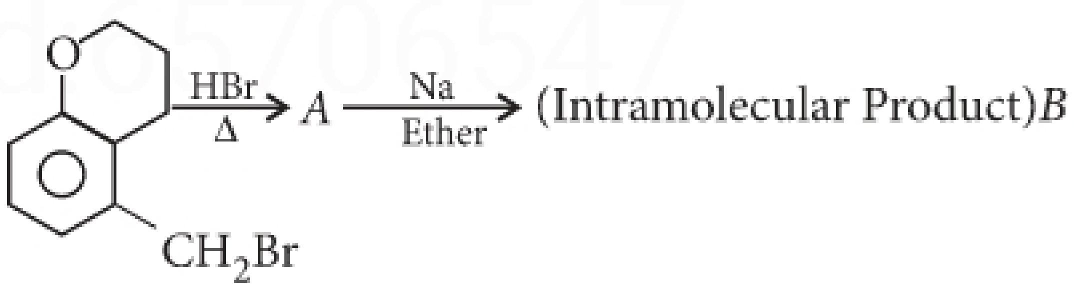
(a) 3, diamagnetic (b) 3, paramagnetic
(c) $2\frac{1}{2}$, paramagnetic (d) $2\frac{1}{2}$, diamagnetic

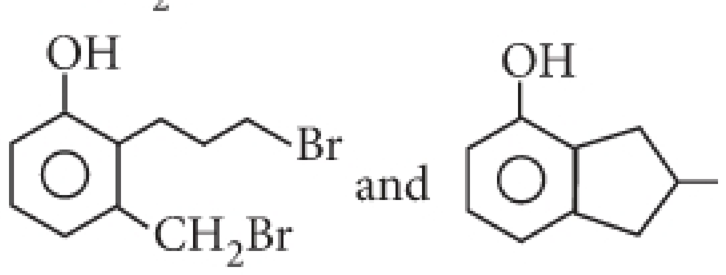
17. Among the statements (*A*) - (*D*), the incorrect ones are

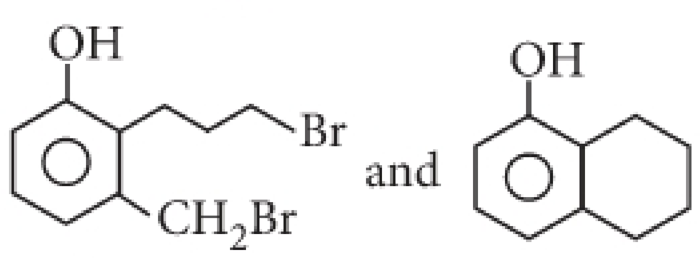
(*A*) Octahedral Co(III) complexes with strong field ligands have very high magnetic moments
(*B*) When $\Delta_o < P$, the *d*-electron configuration of Co(III) in an octahedral complex is $t_{2g}^4\, e_g^2$.
(*C*) Wavelength of light absorbed by $[Co(en)_3]^{3+}$ is lower than that of $[CoF_6]^{3-}$.
(*D*) If the Δ_o for an octahedral complex of Co(III) is 18,000 cm^{-1}, then Δ_t for its tetrahedral complex with the same ligand will be 16,000 cm^{-1}.

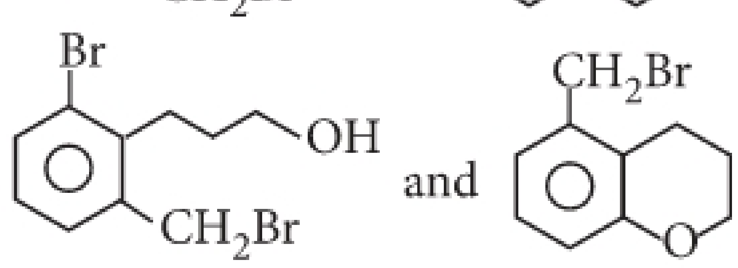
(a) (*A*) and (*D*) only (b) (*C*) and (*D*) only
(c) (*B*) and (*C*) only (d) (*A*) and (*B*) only.

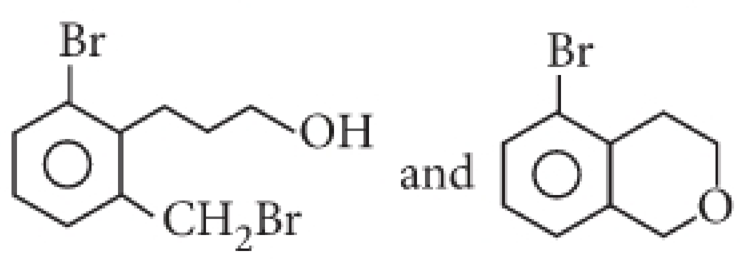
18. In the following reaction sequence, structures of *A* and *B*, respectively will be



(a) 

(b) 

(c) 

(d) 

19. The ammonia (NH_3) released on quantitative reaction of 0.6 g urea (NH_2CONH_2) with sodium hydroxide (NaOH) can be neutralised by

(a) 100 mL of 0.2 N HCl
(b) 200 mL of 0.4 N HCl
(c) 200 mL of 0.2 N HCl
(d) 100 mL of 0.1 N HCl

20. For the reaction,

$2H_{2(g)} + 2NO_{(g)} \rightarrow N_{2(g)} + 2H_2O_{(g)}$

the observed rate expression is, rate = $k_f\,[NO]^2[H_2]$. The rate expression for the reverse reaction is

(a) $k_b[N_2][H_2O]^2/[H_2]$ (b) $k_b[N_2]\,[H_2O]$
(c) $k_b[N_2]\,[H_2O]^2$ (d) $k_b[N_2]\,[H_2O]^2/[NO]$

21. The standard heat of formation ($\Delta_f H^\circ_{298}$) of ethane (in kJ/mol), if the heat of combustion of ethane, hydrogen and graphite are –1560, –393.5 and –286 kJ/mol, respectively is ________.

22. The flocculation value of HCl for arsenic sulphide sol is 30 mmol L^{-1}. If H_2SO_4 is used for the flocculation of arsenic sulphide, the amount, in grams, of H_2SO_4 in 250 mL required for the above purpose is ________.
(Molecular mass of H_2SO_4 = 98 g/mol)

23. 3 g of acetic acid is added to 250 mL of 0.1 M HCl and the solution made up to 500 mL. To 20 mL of this solution 1/2 mL of 5 M NaOH is added. The pH of the solution is ________.
[Given : pK_a of acetic acid = 4.75, molar mass of acetic acid = 60 g/mol, log 3 = 0.4771]
Neglect any changes in volume.

24. Consider the following reactions

$NaCl + K_2Cr_2O_7 + \underset{\text{(conc.)}}{H_2SO_4} \rightarrow A$ + side products

(*A*) + NaOH → (*B*) + side products

(*B*) + $\underset{\text{(dilute)}}{H_2SO_4}$ + H_2O_2 → (*C*) + side products

The sum of the total number of atoms in one molecule each of (*A*), (*B*) and (*C*) is ________.

25. The number of sp^2-hybridised carbons present in "Aspartame" is ________.

SOLUTIONS

1. (c)	2. (None)	3. (d)	4. (c)
5. (a)	6. (d)	7. (a)	8. (c)
9. (b)	10. (b)	11. (b)	12. (c)
13. (b)	14. (a)	15. (d)	16. (a)
17. (a)	18. (b)	19. (a)	20. (a)
21. (–192.5 or –85.00)		22. (0.37)	
23. (5.23)	24. (18)	25. (9)	

For detail solutions, Refer to MTG NTA JEE Main January 2020 Solved Papers.

JEE Main

NUMERICAL VALUE TYPE QUESTIONS

Exam on 5th, 7th to 9th & 11th April, 2020

1. 10.0 g FeS is treated with dil. sulphuric acid and produced gas is passed through aqueous solution of $CdCl_2$. The weight of CdS is 14.4 g. The percentage purity of FeS is ______. [Atomic mass of Cd = 112]

2. The minimum volume (in L) of water required to dissolve 1 g of calcium sulphate at 298 K is ______. (For calcium sulphate, $K_{sp} = 9.1 \times 10^{-6}$)

3. In 100 g of naphthalene, 2.423 g of sulphur was dissolved. Melting point of naphthalene = 80.1°C. $\Delta T_f = 0.661$°C, $L_f = 35.7$ cal/g of naphthalene. If the molecular formula of sulphur added is S_x, then value of x is ______.

4. The number of isomeric ketones having the molecular formula, $C_6H_{12}O$ undergo iodoform test is ______.

5. The magnetic moment of a transition metal ion is found to be 3.87 BM. The number of unpaired electrons present in it is ______.

6. The root mean square speed of ozone kept in a closed vessel at 20°C and pressure of 82 cm of Hg is $x \times 10^4$ cm/sec. The value of x is ______.

7. For a first order reaction at 300°C, activation energy is 35 kcal mol^{-1} and the frequency constant is 1.45×10^{11} s^{-1}. If the rate constant is $x \times 10^{-3}$, then the value of x is ______.

8. 0.1877 g of an organic compound when analysed by the Duma's method yields 31.7 mL of moist nitrogen measured at 14°C and 758 mm of mercury. The percentage of nitrogen in the organic compound is ______.
(Aqueous tension at 14°C = 12 mm)

9. Emission transitions in the Paschen series end at orbit n = 3 and start from orbit n and can be represented as $\upsilon = 3.29 \times 10^{15}$ (Hz) $[1/3^2 - 1/n^2]$. If the transition is observed at 1285 nm then the value of n is ______.

10. 36.4 g of 1,1,2,2-tetrachloropropane was heated with zinc dust and the product was bubbled through ammoniacal $AgNO_3$. The weight of precipitate (in g) obtained is ______.

SOLUTIONS

1. **(88) :** According to the question, the reaction is written as $FeS + H_2SO_4 \rightarrow FeSO_4 + H_2S$
$CdCl_2 + H_2S \rightarrow CdS + 2HCl$
Therefore, moles of FeS = moles of H_2S = moles of CdS
or,
$$\frac{\text{Weight of FeS}}{\text{Molecular weight of FeS}} = \frac{\text{Weight of CdS}}{\text{Molecular weight of CdS}}$$
Let mass of FeS reacted is W.
or, $\frac{W}{88} = \frac{14.4}{144}$ or, $10W = 88$ or, $W = 8.8$ g
Since 10.0 g sample contains 8.8 g FeS
$\therefore$ 1 g sample contains $\frac{8.8}{10}$ g FeS
$\therefore$ 100 g sample contains $\frac{8.8}{10} \times 100$ g FeS = 88.0 g
$\therefore$ Percentage purity = 88%

2. **(2.43) :** $CaSO_4$ dissociates as
$CaSO_{4(s)} \rightleftharpoons Ca^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$
Let S be the solubility of $CaSO_4$ in moles L^{-1}.
$K_{sp} = [Ca^{2+}][SO_4^{2-}] = S^2$
or $S = \sqrt{K_{sp}} = \sqrt{9.1 \times 10^{-6}} = 3.016 \times 10^{-3}$ mol L^{-1}
$= 3.016 \times 10^{-3} \times 136$ g L^{-1} = 0.411 g L^{-1}
(Molar mass of $CaSO_4$ = 136 g mol^{-1})
For dissolving 0.411 g of $CaSO_4$, water required = 1 L
$\therefore$ For dissolving 1 g of $CaSO_4$, water required $= \frac{1}{0.411}$ L = 2.43 L

3. **(8) :**
$$M_2 = \frac{1000 \times K_f \times w_2}{w_1 \times \Delta T_f} = \frac{1000 \times w_2}{w_1 \times \Delta T_f} \times \frac{R \times T_f^2}{1000\, L_f}$$

$w_2 = 2.423$ g; $w_1 = 100$ g; $R = 2$ cal degree^{-1} mol^{-1}
$T_f = 80.1 + 273 = 353.1$ K

$$M_2 = \frac{1000 \times 2.423}{0.661 \times 100} \times \frac{2 \times (353.1)^2}{1000 \times 35.7} = 256$$

Molecular mass of $S_x = 256$; Hence, $x = 8$

4. (4) : Four isomeric ketones *i.e.*, $CH_3COCH_2CH_2CH_2CH_3$, $CH_3COCH(CH_3)CH_2CH_3$, $CH_3COCH_2CH(CH_3)_2$ and $CH_3COC(CH_3)_3$ undergo iodoform test.

5. (3) : Magnetic moment, $\mu = 3.87$ B.M. corresponds to the number of unpaired electrons, $n = 3$ by applying the formula, $\mu = \sqrt{n(n+2)}$ B.M.

6. (3.90) : Firstly, let us calculate the volume of gas at given conditions for 1 mole.
$P_1 = 76$ cm of Hg, $V_1 = 22400$ cm^3 at STP
$T_1 = 273$ K, $P_2 = 82$ cm of Hg
$T_2 = 273 + 20 = 293$ K

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{76 \times 22400}{273} \times \frac{293}{82} = 22282 \text{ cm}^3$$

$P_2 = 82$ cm $= 82 \times 13.6 \times 981$ dynes cm^{-2}

$$u_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{M}}$$

$$= \sqrt{\frac{3 \times 82 \times 13.6 \times 981 \times 22282}{48}} = 3.90 \times 10^4 \text{ cm/s}$$

7. (7.96) : $\log k = \log A - \dfrac{E_a}{2.303RT}$

$$\log k = \log(1.45 \times 10^{11}) - \frac{35 \times 10^3}{2.303 \times 2 \times 573}$$

$\log k = 11.161 - 13.26 = -2.099$
Taking antilog, $k = 7.96 \times 10^{-3}$ s^{-1}

8. (19.71) : Experimental temperature = 14°C
Experimental pressure = 758 mm Hg
Volume of N_2 liberated under experimental condition = 31.7 mL
Aqueous tension at 14°C = 12 mm Hg.
Pressure at which N_2 is collected = 758 – 12 = 746 mm Hg.
First we have to convert the volume of N_2 liberated under experimental condition into NTP by using gas equation.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \text{ or } \frac{746 \times 31.7}{(273+14)} = \frac{760 \times V_2}{273}$$

$$\therefore\ V_2 = \frac{746 \times 31.7 \times 273}{760 \times 287} = 29.6 \text{ mL}$$

$$\%\ N = \frac{V}{8W} = \frac{29.6}{8 \times 0.1877} = 19.71\%$$

9. (5): $\upsilon = \dfrac{c}{\lambda} = \dfrac{3.0 \times 10^8 \text{ m s}^{-1}}{1285 \times 10^{-9} \text{ m}} = 3.29 \times 10^{15}\left(\dfrac{1}{3^2} - \dfrac{1}{n^2}\right)$

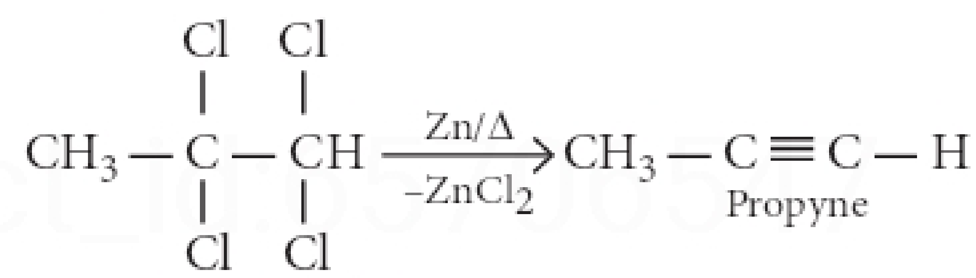
or, $\dfrac{3.0 \times 10^8}{1285 \times 10^{-9}} \times \dfrac{1}{3.29 \times 10^{15}} = \dfrac{1}{9} - \dfrac{1}{n^2}$

or, $\dfrac{1}{n^2} = \dfrac{1}{9} - \dfrac{3.0 \times 10^8}{1285 \times 10^{-9}} \times \dfrac{1}{3.29 \times 10^{15}}$

or, $\dfrac{1}{n^2} = 0.111 - 0.071 = 0.04 = \dfrac{1}{25}$

$\therefore\ n^2 = 25 \Rightarrow n = 5$

10. (29.4) : The halogenation of vicinal tetrahaloalkane gives alkynes. It is done by heating the compound with Zn dust.



1, 1, 2, 2-tetrachloropropane
(Molecular weight = 182)

$$CH_3-C\equiv C-H + AgNO_3 \xrightarrow[\Delta]{NH_4OH}$$

$$CH_3-C\equiv C-Ag + NH_4NO_3 + H_2O$$

Silver propynide (ppt.)
(Mol. wt. = 147)

$\therefore$ 182 g of tetrachloroalkane gives 147 g of ppt.

$\therefore$ 36.4 g of tetrachloroalkane gives $\dfrac{147 \times 36.4}{182} = 29.4$ g of precipitate

Solution Senders of Chemistry Musing

Set - 79

- Ankit Moond, Rajasthan
- Abhishek Arora, Chandigarh
- Gulshan Shah, West Bengal

Solution Senders of Unscrambled Words

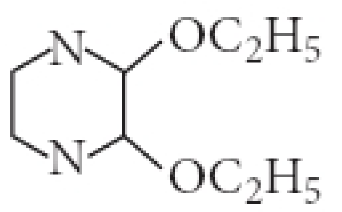
- Pasas Bali, Jammu & Kashmir
- Jayant Kohli, New Delhi

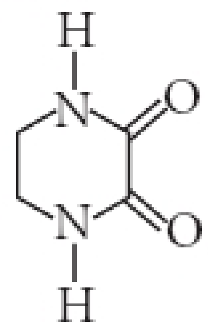
GEAR UP FOR JEE MAIN 2020

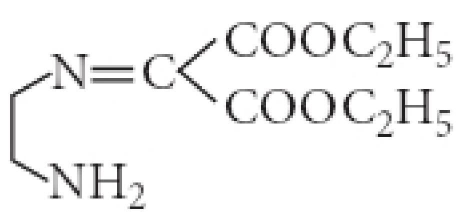
Exam on : 05th, 07th to 09th & 11th April, 2020

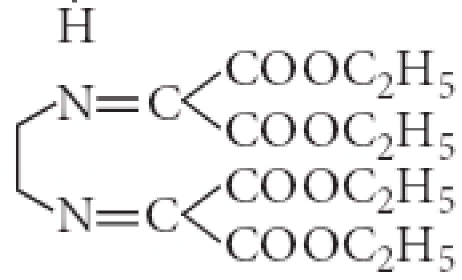
with Numerical Value Type Questions

1. When $H_2N—CH_2—CH_2—NH_2$ reacts with diethyl oxalate. What will be the product?

(a) 

(b) 

(c) 

(d) 

2. Densities of two gases are in the ratio of 1 : 2 and their temperatures are in the ratio of 2 : 1, then the ratio of their respective pressures is

(a) 1 : 1 (b) 1 : 2 (c) 2 : 1 (d) 4 : 1

3. Which of the following '*gem*' diols is stable?

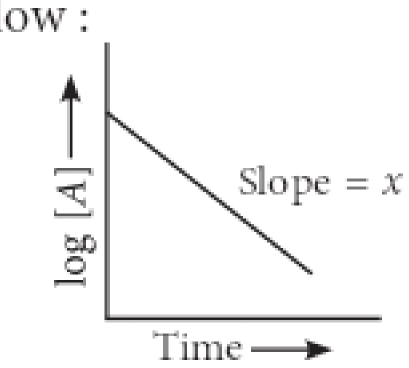
(a) $CH_3—C(OH)_2—H$ (b) $CBr_3—C(OH)_2—H$

(c) $CF_3—C(OH)_2—H$ (d) $C_6H_5—C(OH)_2—C_6H_5$

4. The BCl_3 is a planar molecule whereas NCl_3 is pyramidal because

(a) N—Cl bond is more covalent than B—Cl bond
(b) B—Cl bond is more polar than N—Cl bond
(c) Nitrogen atom is smaller than boron
(d) BCl_3 has no lone pair but NCl_3 has a lone pair of electrons.

5. For a first order reaction, the graph between log [*A*] *vs t* is given below :



here, *x* is equal to

(a) $\frac{0.693}{k}$ (b) $\frac{k}{2.303}$ (c) $-\frac{k}{2.303}$ (d) $\log[A]_0$

6. Which of the following statements is correct for the $[Fe(H_2O)_5NO]SO_4$ complex?

(a) The EAN value of Fe in this complex depends on the charge of NO ligand.
(b) The EAN value of Fe in this complex does not depend on the charge of NO ligand.
(c) The hybridisation of the central atom is d^2sp^3.
(d) It is paramagnetic with μ = 1.73 B.M.

7. Positive deviation from ideal gas behaviour takes place because of

(a) molecular interaction between atoms and $\frac{PV}{nRT} > 1$
(b) molecular interaction between atoms and $\frac{PV}{nRT} < 1$
(c) finite size of atoms and $\frac{PV}{nRT} > 1$
(d) finite size of atoms and $\frac{PV}{nRT} < 1$.

8. For the following data,

$0.5\ H_{2(g)} + 0.5\ Cl_{2(g)} \rightarrow HCl;\ \Delta H^\circ = -22060$ cal (at 298 K)

The mean heat capacities over this temperature range are,

$H_{2(g)}$, $C_p = 6.82$ cal mol^{-1} K^{-1}
$Cl_{2(g)}$, $C_p = 7.71$ cal mol^{-1} K^{-1}
$HCl_{(g)}$, $C_p = 6.81$ cal mol^{-1} K^{-1}

What will be the heat of formation of HCl at 348 K?

(a) –20095 cal (b) –32758 cal
(c) –37725 cal (d) –22083 cal

9. The equivalent conductances of two strong electrolytes at infinite dilution in H_2O (where ions move freely through a solution) at 25 °C are given below :

$\Lambda^\circ_{CH_3COONa} = 91.0$ S cm^2/equiv.
$\Lambda^\circ_{HCl} = 426.2$ S cm^2/equiv.

What additional value one needs to calculate Λ° of an aqueous solution of acetic acid?

(a) $\Lambda°$ of chloroacetic acid ($ClCH_2COOH$)
(b) $\Lambda°$ of NaCl
(c) $\Lambda°$ of CH_3COOK
(d) The limiting equivalent conductance of H^+ ($\lambda^\circ_{H^+}$).

10. The reason for double helical structure of DNA is
(a) van der Waals' forces
(b) dipole-dipole interaction
(c) hydrogen bonding
(d) electrostatic attractions.

11. The equilibrium constant for the decomposition of water, $H_2O_{(g)} \rightarrow H_{2(g)} + \frac{1}{2}O_{2(g)}$ is given by
(α = degree of dissociation of $H_2O_{(g)}$; p = Total equilibrium pressure)

(a) $K_p = \dfrac{\alpha^2 p^{1/2}}{(1+\alpha)(2-\alpha)^{1/2}}$

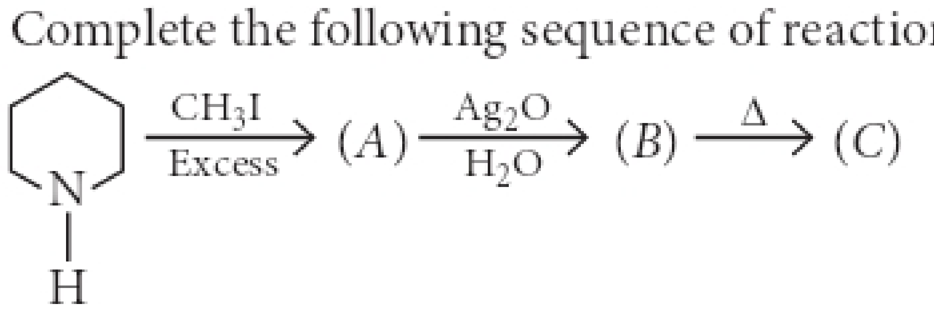
(b) $K_p = \dfrac{\alpha^{3/2} p^{1/2}}{(1-\alpha)(2+\alpha)^{1/2}}$

(c) $K_p = \dfrac{\alpha^3 p^{1/2}}{\sqrt{2}}$

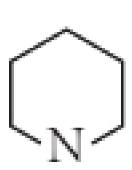
(d) $K_p = \dfrac{\alpha^3 p^{1/2}}{(1-\alpha)(2+\alpha)^{1/2}}$

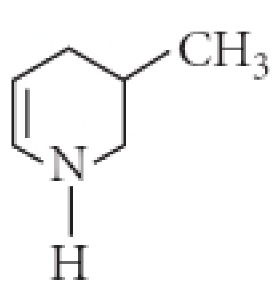
12. Which of the following statements is incorrect in the context of the B – F bond in BF_3?
(a) All the three B – F bond lengths are equal and each of them is shorter than the sum of the covalent radii of boron and fluorine.
(b) The bond energy of B – F bond is very high, higher than for any other single bond.
(c) The unusual shortness and strength of B – F bond may be explained by a $p\pi$-$p\pi$ interaction between boron and fluorine atoms.
(d) The unusual shortness and strength of the bonds may be explained by a $p\pi$-$d\pi$ interaction between the atoms of boron and fluorine.

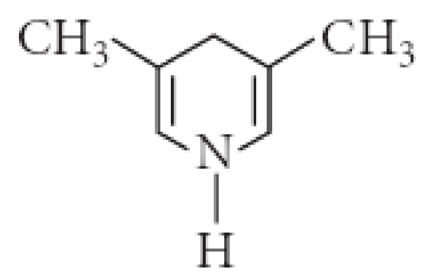
13. Complete the following sequence of reactions,

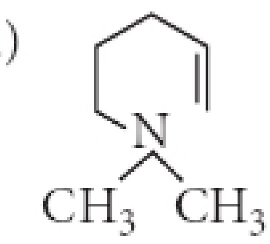


Identify the final product '*C*'.

(a) 

(b) 

(c) 

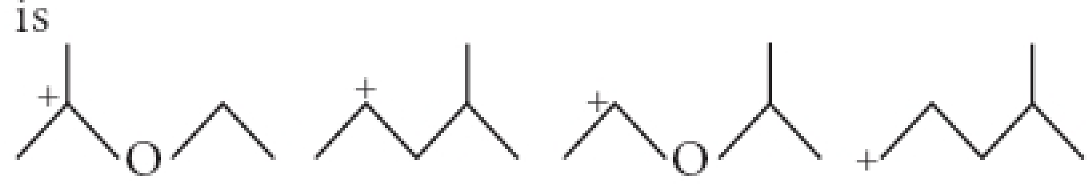
(d) 

14. Arrange (I) Ce^{3+}, (II) La^{3+}, (III) Pm^{3+} and (IV) Yb^{3+} in increasing order of their ionic radii.
(a) IV < III < I < II
(b) I < IV < III < II
(c) IV < III < II < I
(d) III < II < I < IV

15. A solid has structure in which 'W' atoms are located at the corners of a cubic lattice, 'O' atoms at the centre of edges and Na atoms at the centre of the cube. The formula for the compound is
(a) Na_2WO_3
(b) Na_2WO_2
(c) $NaWO_2$
(d) $NaWO_3$

16. Which one of the following statements is true for all the alkali metals?
(a) Their nitrates decompose on heating to give NO_2 and O_2.
(b) Their carbonates decompose on heating to give CO_2 and the metal oxide.
(c) They react with oxygen to give mainly the oxides, M_2O.
(d) They react with halogens to give the halides, *MX*.

17. The correct stability order for the following species is



(I) (II) (III) (IV)

(a) (II) > (IV) > (I) > (III)
(b) (I) > (II) > (III) > (IV)
(c) (II) > (I) > (IV) > (III)
(d) (I) > (III) > (II) > (IV)

18. Identify a reagent from the following list which can easily distinguish between 1-butyne and 2-butyne.
(a) Bromine, CCl_4
(b) H_2, Lindlar catalyst
(c) Dilute H_2SO_4, $HgSO_4$
(d) Ammoniacal Cu_2Cl_2 solution.

19. In the Ellingham diagram, $\Delta_f G°$ vs T plot, which of the following reactions have slope downward?

(a) $Mg + \frac{1}{2}O_2 \longrightarrow MgO$

(b) $2Ag + \frac{1}{2}O_2 \longrightarrow Ag_2O$

(c) $C + \frac{1}{2}O_2 \longrightarrow CO$

(d) $CO + \frac{1}{2}O_2 \longrightarrow CO_2$

20. Identify the product Y in the following sequence,

$$CH_3CHO + CH_3MgI \xrightarrow{\text{Ether}} X \xrightarrow{H_2O/H^+} Y$$

(a) CH_3OH (b) CH_3CH_2OH
(c) $(CH_3)_2CHOH$ (d) $(CH_3)_3COH$

NUMERICAL VALUE TYPE

21. Compound $PdCl_4{\cdot}6H_2O$ is a hydrated complex. 1 M aqueous solution of it has freezing point 269.28 K. Assuming 100% ionisation of complex, then the number of ions furnished by complex in the solution is________.

22. The molecular weight of glycerine if its solution containing 10 g of glycerine per litre is isotonic with a 2% solution of glucose, is________.

23. An α-particle has initial kinetic energy of 25 eV and it is accelerated through a potential difference of 150 volt. If a proton has initial kinetic energy of 25 eV and it is accelerated through a potential difference of 25 volt, then, the approximate ratio of the final wavelengths associated with the proton and the α-particle is________.

24. The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The sum of ratio of number of their molecules is________.

25. Temperature coefficient for the saponification of an ester by NaOH is 1.75. The activation energy will be ________.

SOLUTIONS

1. (b)

2. (a) : We know that, $\dfrac{d_1T_1}{P_1} = \dfrac{d_2T_2}{P_2}$

It is given that, $d_1 = 2d_2$ and $T_2 = 2T_1$

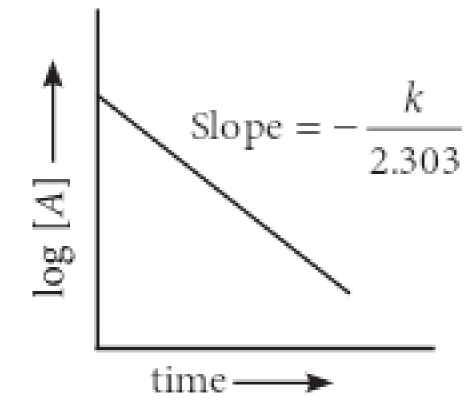
$$\therefore \quad \frac{2d_2 \times T_1}{P_1} = \frac{d_2 \times 2T_1}{P_2} \quad \Rightarrow \quad P_1 = P_2$$

Therefore, ratio of their pressure is 1 : 1.

3. (c) **4. (d)**

5. (c) : For first order reaction,

$$\log[A] = -\frac{kt}{2.303} + \log[A]_0$$



6. (b) : $[Fe(H_2O)_5NO]^{2+}$
Hybridisation : sp^3d^2 (number of unpaired electrons = 3), μ = 3.87 B.M.
Inspite of electronic transition from NO to Fe^{2+}, total number of electrons remains conserved.
Hence, EAN does not change.

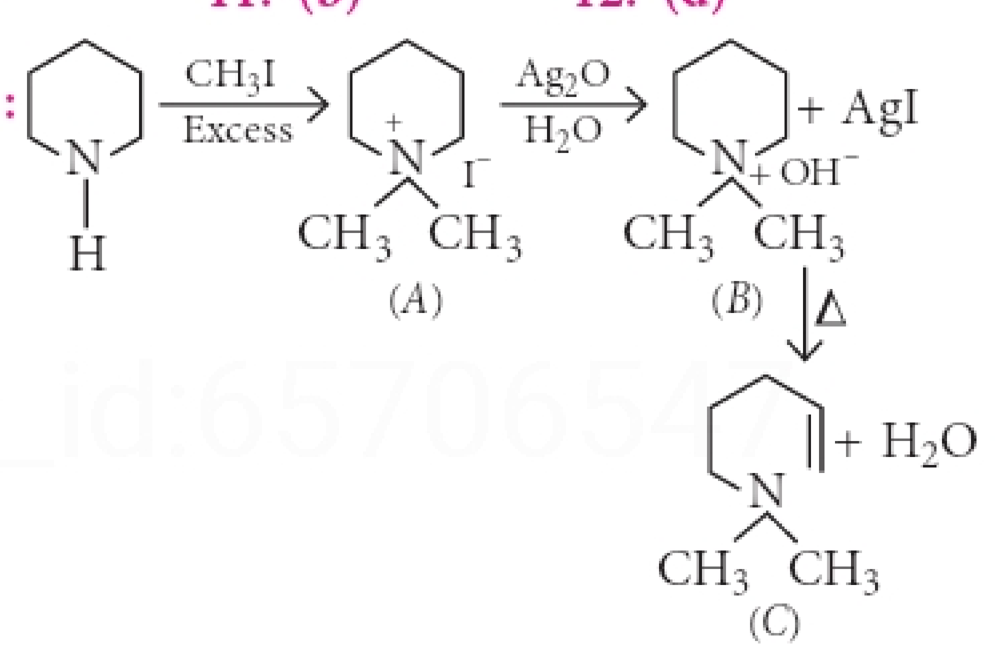
7. (a)

8. (d) : $\Delta C_p = 6.81 - 0.5\,(6.82 + 7.71) = -0.455$
$\Delta H^\circ_{348} = \Delta H^\circ_{298} + \Delta C_p(T_2 - T_1)$
$= -22060 - (0.455 \times 50) = -22083$ cal

9. (b) : According to Kohlrausch's law, the molar conductivity at infinite dilution (Λ°) for a weak electrolyte, CH_3COOH is,
$\Lambda^\circ_{CH_3COOH} = \Lambda^\circ_{CH_3COONa} + \Lambda^\circ_{HCl} - \Lambda^\circ_{NaCl}$
So, for calculating the value of $\Lambda^\circ_{CH_3COOH}$, value of Λ°_{NaCl}, should also be known.

10. (c) **11. (b)** **12. (d)**

13. (d) :



14. (a) : Ionic radii decrease across lanthanide series due to lanthanide contraction. As all ions are in +3 oxidation state, so ionic radii will follow the trend of atomic radii.

$$\therefore \quad \underset{\text{II}}{La^{3+}} > \underset{\text{I}}{Ce^{3+}} > \underset{\text{III}}{Pm^{3+}} > \underset{\text{IV}}{Yb^{3+}}$$

15. (d) : In a unit cell, W-atoms at the corner $= \dfrac{1}{8} \times 8 = 1$

O-atoms at the centre of edges $= \dfrac{1}{4} \times 12 = 3$

Na-atoms at the centre of the cube = 1

Monthly Test Drive CLASS XI ANSWER KEY

1. (c)	2. (a)	3. (a)	4. (a)	5. (a)
6. (a)	7. (b)	8. (a)	9. (b)	10. (c)
11. (c)	12. (c)	13. (c)	14. (a)	15. (c)
16. (c)	17. (a)	18. (d)	19. (a)	20. (b,c)
21. (a,c)	22. (a,b,c,d)	23. (a,b,c,d)	24. (1)	25. (5)
26. (5.5)	27. (b)	28. (a)	29. (c)	30. (d)

W : O : Na = 1 : 3 : 1
Hence, formula = $NaWO_3$

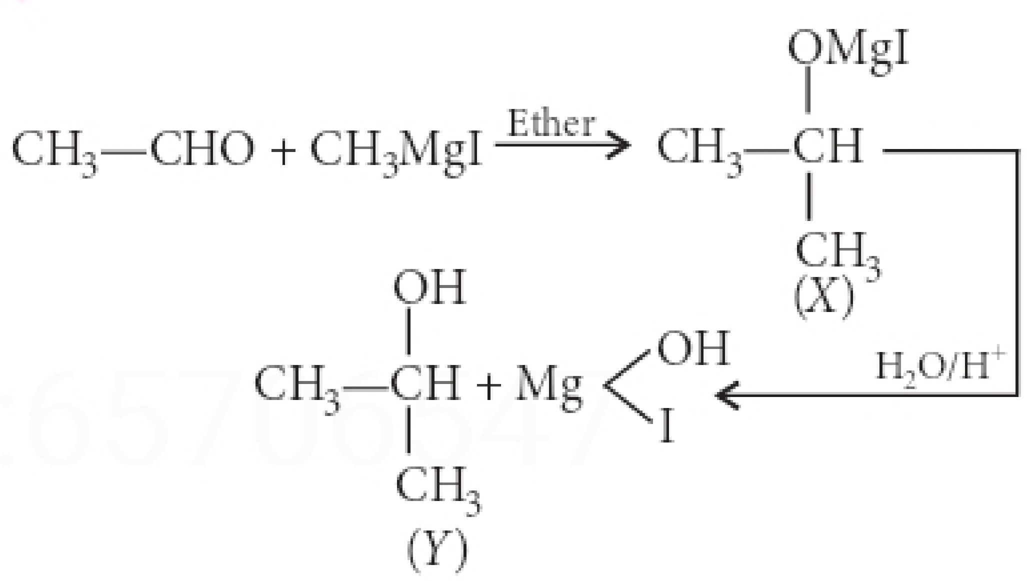
16. (d) : Alkali metals react with halogen to give halides. They are normally represented by M^+X^-.

17. (d)

18. (d) : 1-Butyne has terminal acidic hydrogen while 2-butyne does not have. 1-Butyne will give a red ppt. of $CH_3CH_2C{\equiv}C{-}Cu$ with ammoniacal Cu_2Cl_2 solution while 2-butyne will not.

19. (c) : $C_{(s)} + \frac{1}{2}O_{2(g)} \longrightarrow CO_{(g)}$; ΔS increases.
Hence, as the temperature increases, $T\Delta S$ increases and hence, ΔG (= $\Delta H - T\Delta S$) decreases. In other words, the slope of the curve for formation of CO decreases. However, for all other oxides it increases.

20. (c) :



21. (2) : $\Delta T = iK_f m$
$(273 - 269.28) = i \times 1.86 \times 1$
$3.72 = i \times 1.86$ $\quad$ [$\because K_f$ for water is 1.86 K kg mol^{-1}]
$i = 2$

$$\alpha = \frac{i-1}{n-1}; (\alpha = 100\% = 1) \; 1 = \frac{2-1}{n-1} \Rightarrow n = 2$$

22. (90) : For being isotonic,

$$\pi_{\text{glycerine}} = \pi_{\text{glucose}}, \frac{n_1}{V_1}RT = \frac{n_2}{V_2}RT$$

$$\frac{10}{M} \times \frac{1}{1} = \frac{2}{180} \times \frac{1000}{100}$$

(2% solution means 2 g glucose in 100 mL of solution, density of water = 1 g/cm^3)

$$M = \frac{10 \times 18}{2} = 90$$

23. (5) : $\lambda_\alpha = \frac{0.101}{\sqrt{V}}$ Å, $\lambda_\alpha = \frac{0.101}{\sqrt{\left(150 + \frac{25}{2}\right)}}$ Å;

$\lambda_p = \frac{0.286}{\sqrt{V}}$ Å, $\lambda_p = \frac{0.286}{\sqrt{50}}$ Å

$$\Rightarrow \frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{162.5}{50}} \times \frac{0.286}{0.101} \simeq 5$$

24. (39) : Let the mass of $O_2 = x$ and that of $N_2 = 4x$

No. of molecules of $O_2 = \frac{x}{32}$

No. of molecules of $N_2 = \frac{4x}{28} = \frac{x}{7}$

Ratio $= \frac{x}{32} : \frac{x}{7}$ or 7 : 32

then sum of ratio of their number of molecules = 7 + 32 = 39

25. (10.21) : Temperature coefficient *i.e.*, $\frac{k_2}{k_1} = 1.75$

In general practice, T_1 is taken as 25°C *i.e.*, 298 K and T_2 as 35°C *i.e.*, 308 K

Thus, $\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$

$$\log 1.75 = \frac{E_a}{2.303 \times 1.987} \times \left[\frac{10}{308 \times 298}\right]$$

E_a = 10.207 kcal mol^{-1}

EXAM CORNER 2020

Exam	Date
JEE Main II	05th, 07th to 09th & 11th April
VITEEE	13th to 19th April
SRMJEEE	12th to 20th April
J & K CET	19th April
Kerala PET	20th & 21st April
Karnataka CET	22nd & 23rd April
NEET	3rd May
COMEDK (Engg.)	10th May
AMU (Engg.)	10th May
UPSEE	10th May
BITSAT	16th to 25th May
MHT CET	16th to 20th May
JEE Advanced	17th May

JEE 2020 PRACTICE PAPER ADVANCED

Exam on 17th May

PAPER - I

SECTION 1 (Maximum Marks : 12)

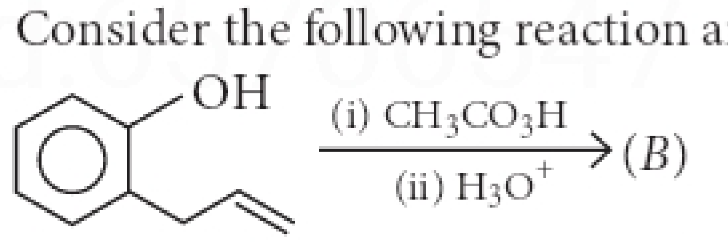
- *This section contains FOUR (04) questions.*
- *Each question has FOUR options. ONLY ONE of these four options is the correct answer.*
- *For each question, choose the option corresponding to the correct answer.*
- *Answer to each question will be evaluated according to the following marking scheme :*

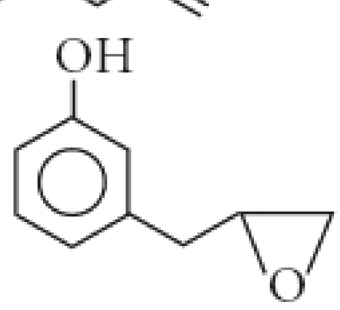
Full Marks : +3 *If ONLY the correct option is chosen.*

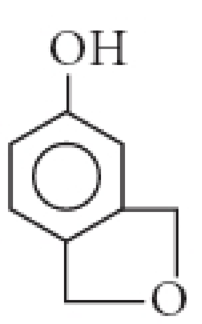
Zero Marks : 0 *If none of the options is chosen (i.e. the question is unanswered).*

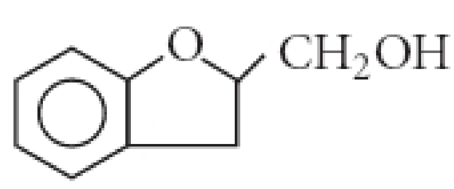
Negative Marks : –1 *In all other cases.*

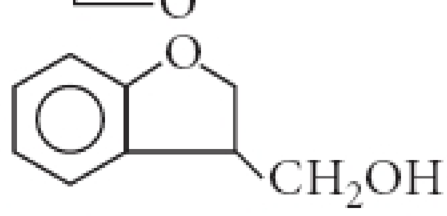
1. Consider the following reaction and identify (*B*).



(a) 

(b) 

(c) 

(d) 

2. Volume of N_2 at 1 atm, 273 K required to form a monolayer on the surface of iron catalyst is 8.15 mL/g of the adsorbent. What will be the surface area of the adsorbent per gram if each nitrogen molecule occupies 16×10^{-22} m^2?

(a) 16×10^{-16} cm^2/g (b) 0.35 m^2/g
(c) 39 m^2/g (d) 22400 cm^2/g

3. For a hydrogen like species, if de-Broglie wavelength in n^{th} orbit is $\lambda_{n,Z}$ and $\lambda_{n+1,Z} + \lambda_{n-1,Z} = 3\lambda_0$, then value of n and species will be (where Z = atomic no., λ_0 = de-Broglie wavelength in ground state of H-atom.

(a) $n = 3$, Li^{2+} (b) $n = 2$, He^+
(c) $n = 3$, He^+ (d) $n = 1$, H

4. Hydrolysis of one mole of peroxodisulphuric acid produces

(a) two moles of sulphuric acid
(b) two moles of peroxomonosulphuric acid
(c) one mole of sulphuric acid and one mole of peroxomonosulphuric acid
(d) one mole of sulphuric acid, one mole of peroxomonosulphuric acid and one mole of hydrogen peroxide.

SECTION 2 (Maximum Marks : 32)

- *This section contains EIGHT (08) questions.*
- *Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).*
- *For each question, choose the option(s) corresponding to (all) the correct answer(s).*
- *Answer to each question will be evaluated according to the following marking scheme :*

Full Marks : +4 *If only (all) the correct option(s) is (are) chosen.*

Partial Marks : +3 *If all the four options are correct but ONLY three options are chosen.*

Partial Marks : +2 *If three or more options are correct but ONLY two options are chosen and both of which are correct.*

Partial Marks : +1 *If two or more options are correct but ONLY one option is chosen and it is a correct option.*

Zero Marks : 0 *If none of the options is chosen (i.e. the question is unanswered).*

Negative Marks : –1 *In all other cases.*

- *For example, in a question, if (a), (b) and (d) are the ONLY three options corresponding to correct answers, then choosing ONLY (a), (b) and (d) will get +4 marks; choosing ONLY (a) and (b) will get +2 marks; choosing ONLY (a) and (d) will get +2 marks; choosing ONLY (b) and (d) will get +2 marks; choosing ONLY (a) will get +1 mark;*

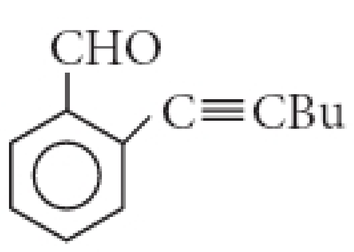
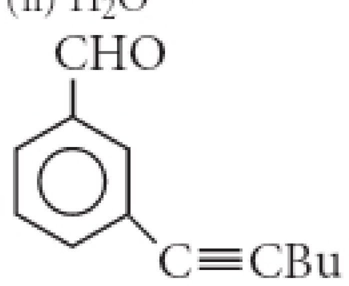
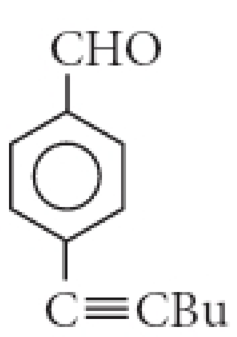
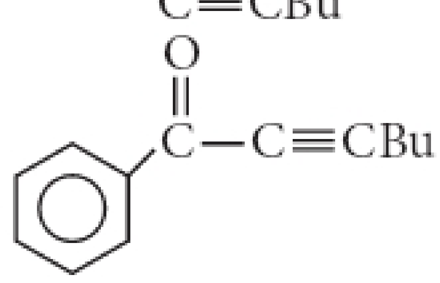
choosing ONLY (b) will get +1 mark;
choosing ONLY (d) will get +1 mark;
choosing no option (i.e. the question is unanswered) will get 0 marks ; and
choosing any other combination of options will get −1 mark.

5. Ag^+ forms many complexes, some of these are $[Ag(NH_3)_2]^+$, $[Ag(CN_2)]^-$, $[Ag(S_2O_3)_2]^{3-}$
Which of the following statements is/are incorrect regarding these complexes?
(a) In these complexes, Ag^+ is a Lewis base.
(b) The hybridisation of Ag^+ is sp^2.
(c) The Ag^+ complexes are good reducing agents.
(d) These complexes are all linear.

6. When nitrobenzene is treated with Br_2 in presence of $FeBr_3$, the major product formed is *m*-bromonitrobenzene. Which of the following statements is/are related to the formation of *m*-isomer?
(a) The electron density on *meta*-carbon is more than that on *ortho*-and *para*-positions.
(b) The intermediate carbonium ion formed after initial attack of Br^+ at the *meta*-position is least destabilised.
(c) Loss of aromaticity when Br^+ attacks at the *ortho* and *para* positions and not at *meta*–position.
(d) Easier loss of H^+ to regain aromaticity from the *meta*-position than from *ortho*-and-*para* positions.

7. Compound *C* in the following reaction can be

$$Bu-C\equiv CH \xrightarrow{LiNH_2} A \xrightarrow[(ii)\ H_2O]{(i)\ PhCHO} B \xrightarrow{MnO_2} C$$

(a) 
(b) 
(c) 
(d) 

8. In the depression of freezing point experiment, it is found that the
(a) vapour pressure of the solution is less than that of pure solvent
(b) vapour pressure of the solution is more than that of pure solution
(c) only solute molecules solidify at the freezing point
(d) only solvent molecules solidify at the freezing point.

9. Three different solutions of oxidising agents $KMnO_4$, $K_2Cr_2O_7$ and I_2 is titrated separately with 0.158 g of $Na_2S_2O_3$. If molarity of each oxidising agent is 0.1 M and reactions are
I. $MnO_4^- + S_2O_3^{2-} \longrightarrow MnO_2 + SO_4^{2-}$
II. $CrO_7^{2-} + S_2O_3^{2-} \longrightarrow Cr^{3+} + SO_4^{2-}$
III. $I_2 + S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + I^-$
then
(a) volume of $KMnO_4$ used is maximum
(b) volume of iodine used is minimum
(c) weight of I_2 used in titration is maximum
(d) gram equivalent of $Na_2S_2O_3$ are same in all the reactions.

10. Which of the following statements is(are) correct?
(a) The coordination number of each type of ion in CsCl crystal is 8.
(b) A metal that crystallizes in *bcc* structure has a coordination number of 12.
(c) A unit cell of an ionic crystal shares some of its ions with other unit cells.
(d) The length of the unit cell in NaCl is 552 pm. (r_{Na^+} = 95 pm; r_{Cl^-} = 181 pm).

11. Which of the following statements is (are) correct with reference to the ferrous and ferric ions?
(a) Fe^{3+} gives brown colour with potassium ferricyanide.
(b) Fe^{2+} gives blue precipitate with potassium ferricyanide.
(c) Fe^{3+} gives red colour with potassium thiocyanate.
(d) Fe^{2+} gives brown colour with ammonium thiocyanate.

12. Which of the following pairs can be distinguished by the action of heat?
(a) Na_2CO_3 and $CaCO_3$ (b) K_2CO_3 and $MgCO_3$
(c) $Ca(NO_3)_2$ and $NaNO_3$
(d) $MgCl_2{\cdot}6H_2O$ and $CaCl_2{\cdot}6H_2O$

SECTION 3 (Maximum Marks : 18)

- *This section contains SIX (06) questions. The answer to each question is a NUMERICAL VALUE.*
- *For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.*
- *Answer to each question will be evaluated according to the following marking scheme :*
  Full Marks : +3 If ONLY the correct numerical value is entered.
  Zero Marks : 0 In all other cases.

13. The rate of decomposition for methyl nitrite and ethyl nitrite can be given in terms of rate constant (in sec^{-1}) k_1 and k_2 respectively. The energy of activations for the two reactions are 152.30 kJ mol^{-1} and 157.7 kJ mol^{-1} as well as frequency factors are 10^{13} and 10^{14} respectively for the decomposition of methyl and ethyl nitrite. The approximate temperature (in K) at which rate constant will be same for the two reactions is _______ .

14. In the following salts,

Na_2S_2, $Na_2S_2O_3$, $Na_2S_2O_4$, $Na_2S_2O_5$, $Na_2S_2O_7$, $Na_2S_2O_8$

x = Total salts which have S—O—S bond

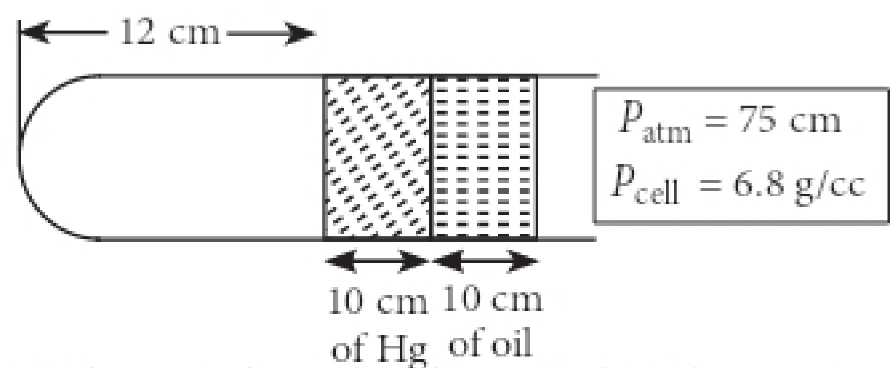
y = Total salts which have S—S linkage

z = Total salts in which both the sulphur atoms are in same O.N. The value of $(x + y + z)$ is _______ .

15. In a conductivity cell, the two platinum electrodes, each of area 10 sq. cm. are fixed 1.5 cm apart. The cell contained 0.05 N solution of a salt. These two electrodes are just half dipped into the solution which has a resistance of 50 ohms, the equivalent conductance (in Ω^{-1} cm^2 eq^{-1}) of the salt solution is _____ .

16. The vapour pressure of pure benzene at a certain temperature is 640 mm Hg. A non-volatile non-electrolyte solid weighing 2.175 g is added to 39.0 g of benzene. The vapour pressure of the solution is 600 mm Hg. The molecular weight of the solid substance is _______ .

17.



If above tube is held vertical with open end upward then, the length of air column (in cm) is _______ .

18. 1,2-Dibromopropane on treatment with X moles of $NaNH_2$ followed by treatment with C_2H_5Br gives a pentyne. The value of X is _______ .

PAPER - II

SECTION 1 (Maximum Marks : 32)

- *This section contains EIGHT (08) questions.*
- *Each question has FOUR options. ONE OR MORE THAN ONE of these four option(s) is(are) correct answer(s).*
- *For each question, choose the option(s) corresponding to (all) correct answer(s).*
- *Answer to each question will be evaluated according to the following marking scheme :*

Full Marks : *+4 If only (all) the correct option(s) is (are) chosen.*

Partial Marks : *+3 If all the four options are correct but ONLY three options are chosen.*

Partial Marks : *+2 If three or more options are correct but ONLY two options are chosen and both of which are correct.*

Partial Marks : *+1 If two or more options are correct but ONLY one option is chosen and it is a correct option.*

Zero Marks : *0 If none of the options is chosen (i.e. the question is unanswered).*

Negative Marks : *–1 In all other cases.*

- *For example, in a question, if (a), (b) and (d) are the ONLY three options corresponding to correct answers, then choosing ONLY (a), (b) and (d) will get +4 marks;*
- *choosing ONLY (a) and (b) will get +2 marks;*
- *choosing ONLY (a) and (d) will get +2 marks;*
- *choosing ONLY (b) and (d) will get +2 marks;*
- *choosing ONLY (a) will get +1 mark;*
- *choosing ONLY (b) will get +1 mark;*
- *choosing ONLY (d) will get +1 mark;*
- *choosing no option (i.e. the question is unanswered) will get 0 marks ; and*
- *choosing any other combination of options will get –1 mark.*

1. Which of the following pairs consist(s) of ore of the same metal?

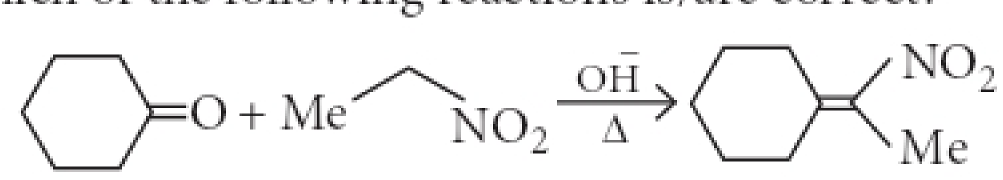
(a) Magnesite, cerussite

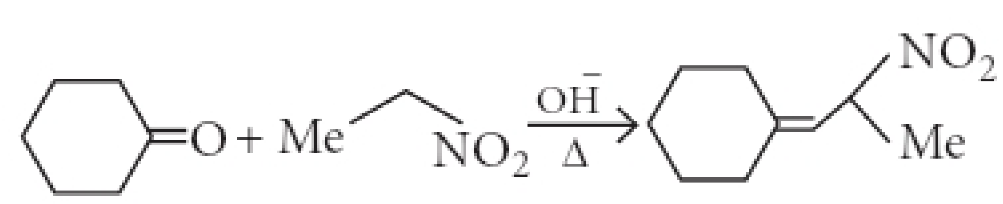
(b) Chalcocite, copper pyrites

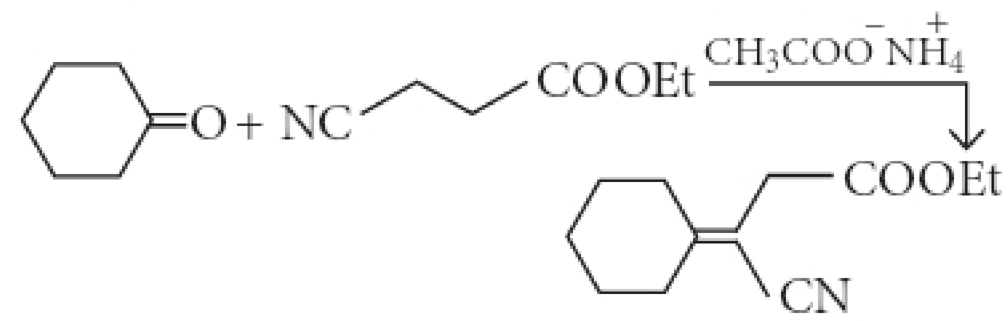
(c) Bauxite, corundum

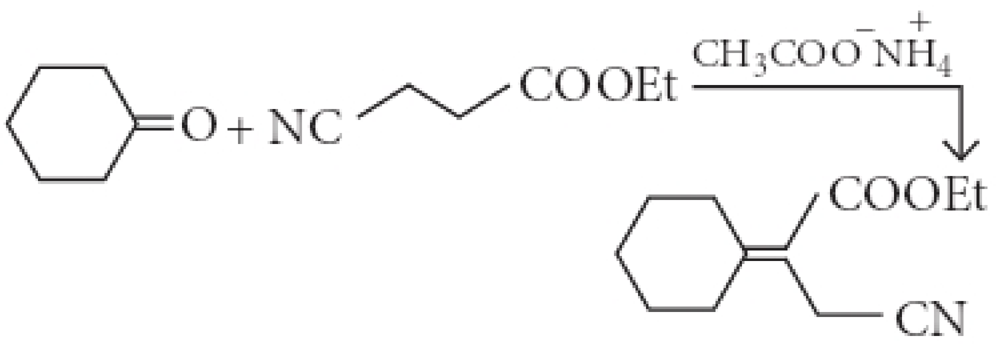
(d) Anglesite, cerussite

2. Which of the following reactions is/are correct?

(a) 

(b) 

(c) 

(d) 

3. Which of the following statements is/are correct when a mixture of NaCl and $K_2Cr_2O_7$ is gently warmed with concentrated H_2SO_4?
(a) Deep red vapours are evolved.
(b) The vapours, when passed into NaOH solution, gives a yellow solution of Na_2CrO_4.
(c) Chlorine gas is evolved.
(d) Chromyl chloride is formed.

4. A mixture of three proteins, (*A*-pepsin), (*B*-haemoglobin), and (*C*-lysozyme) was seperated by electrophoresis method at pH = 7. The pH at isoelectric point (pI) of the proteins are pI of (*A*), (*B*) and (*C*) which are 1.1, 6.7 and 11.0, respectively. Which of the following statements is/are correct?
(a) Pepsin (*A*) will migrate to the cathode.
(b) Lysozyme (*C*) will migrate to the anode.
(c) Haemoglobin (*B*) will not migrate.
(d) At pH = 7, (*A*) and (*C*) would precipitate out while (*B*) would remain in the solution.

5. Select the correct statement(s).
(a) According to Mulliken, electronegativity is related to the average of the ionization energy and electron affinity of the atom when they are expressed in eV/atom.
(b) Electronegativity of an atom having half-filled electronic configuration will be more in general.
(c) $HClO_3$ is weaker acid than HClO.
(d) Electronegativity goes on decreasing with increase in atomic number in general as we move along a period.

6. Aryl halides are less reactive towards nucleophilic substitution reaction as compared to alkyl halides due to
(a) the formation of less stable carbonium ion
(b) resonance stabilisation
(c) longer carbon-halogen bond
(d) double bond between C and halogen.

7. A student collected two values of PV_m for a gas at two different temperatures.

Temperature (°C)	30	300
PV_m (L-atm)	20	40

He considered the gas is ideal. Which of the following correct values, will he obtain on applying ideal gas equation?
(a) 0 K = –273°C (b) 0 K = –240°C
(c) R = 0.0821 L-atm/K-mol
(d) R = 0.0741 L-atm/K-mol

8. The freezing point of equimolal aqueous solutions will be highest for
(a) $C_6H_5NH_3Cl$ (aniline hydrochloride)
(b) $Ca(NO_3)_2$
(c) $La(NO_3)_3$ (d) $C_6H_{12}O_6$ (glucose)

Section 2 (Maximum Marks : 18)

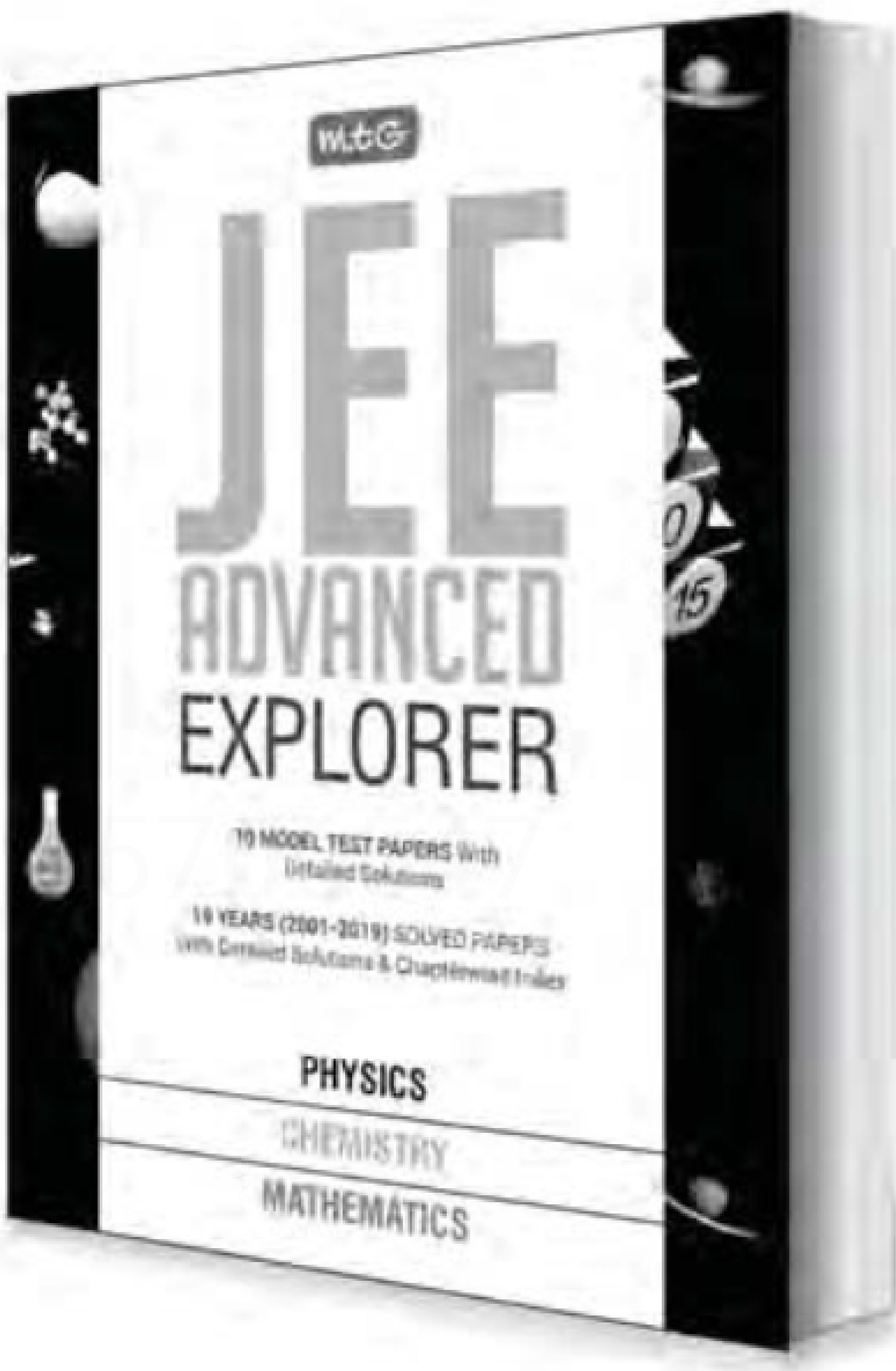
- *This section contains SIX (06) questions. The answer to each question is a NUMERICAL VALUE.*
- *For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, truncate/round-off the value to TWO decimal places.*
- *Answer to each question will be evaluated according to the following marking scheme :*
  Full Marks : *+3 If ONLY the correct numerical value is entered.*
  Zero Marks : *0 In all other cases.*

9. A decapeptide (Mol. Wt. 796) on complete hydrolysis gives glycine (Mol. wt. 75), alanine and phenylalanine. Glycine contributes 47.0% to the total weight of the hydrolysed products. The number of glycine units present in the decapeptide is ______ .

10. 2.68×10^{-3} moles of a solution containing an ion A^{n+} acquire 1.61×10^{-3} moles of MnO_4^- for the oxidation of A^{n+} to AO_3^- in acidic medium. The value of n is ______ .

11. In an electrolysis experiment current was passed for 5 hours through two cells connected in series. The first cell contains a solution of gold and the second contains copper sulphate solution. 9.85 g of gold was deposited in the first cell. If the oxidation number of gold is +3, the amount of copper deposited on the cathode of the second cell is ______ .

12. Solid NH_4I on rapid heating in a closed vessel at 357 °C develops pressure of 300 mm of Hg owing to partial decomposition of NH_4I into NH_3 and HI but the pressure gradually increases further (when the excess solid residue remains in the vessel) owing to the dissociation of HI. The final pressure (mm of Hg) developed at equilibrium is ______ .



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K_p for HI dissocation is 2 at 357°C.

$$\left[HI \rightleftharpoons \frac{1}{2}H_2 + \frac{1}{2}I_2\right]$$

13. The standard enthalpies of formation of $CO_{2(g)}$, $H_2O_{(l)}$ and glucose$_{(s)}$ at 25°C are –400 kJ/mol, –300 kJ/mol and –1300 kJ/mol, respectively. The standard enthalpy of combustion per gram of glucose at 25°C will be ______ .

14. Out of the following, total number of oxides which are basic in nature is ______ .

TiO, Sc_2O_3, Ti_2O_3, VO, V_2O_5, CrO_3, Cr_2O_3, CuO, TiO_3

SECTION 3 (Maximum Marks : 12)

- *This section contains TWO (02) List-Match sets.*
- *Each List-Match set has TWO (02) Multiple Choice Questions.*
- *Each List-Match set has two lists : List-I and List-II.*
- *List-I has Four entries (I), (II), (III) and (IV) and List-II has Six entries (P), (Q), (R), (S), (T) and (U).*
- *FOUR options are given in each Multiple Choice Question based on List-I and List-II and ONLY ONE of these four options satisfies the condition asked in the Multiple Choice Question.*
- *Answer to each question will be evaluated according to the following marking scheme :*

Full Marks : +3 If ONLY the option corresponding to the correct combination is chosen.

Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).

Negative Marks : –1 In all other cases.

Answer Q. 15 and Q. 16 by appropriately matching the lists based on the information given in the paragraph.

Leaching involves the treatment of finely powdered ore with a suitable reagent, which can selectively dissolve the ore but not gangue.

Calcination is the process in which the ore is heated strongly in absence or limited supply of air at a temperature that the ore does not melts.

Roasting is a process in which the ore (usually sulphide) is heated strongly in presence of air, at a temperature below the melting point of the ore.

Smelting involves reduction of ore to the molten metal at a high temperature. For the extraction of less electropositive metals such as Pb, Zn, Fe, Sn etc., powerful reducing agents such as C, H_2, CO, water gas, Na, K, Mg and Al may be used.

List-I (Methods)		List-II (Reactions)	
I.	Leaching	(P)	$2Ag_2O \xrightarrow{Heat} 4Ag + O_2$
II.	Smelting	(Q)	$Al_2O_3{\cdot}2H_2O \xrightarrow{Heat} Al_2O_3 + 2H_2O$
III.	Calcination	(R)	$Fe_3O_4 + 4CO \longrightarrow 3Fe + 4CO_2$
IV.	Roasting	(S)	$CuCO_3{\cdot}MgCO_3 \xrightarrow{Heat} CaO + MgO + CO_2$

15. Which of the following options has the correct combination considering List-I and List-II?

(a) I → Q, R (b) II → P, Q

(c) III → Q, S (d) IV → P, S

16. Which of the following options has the correct combination considering List-I and List-II?

(a) I → P, Q (b) II → P, R

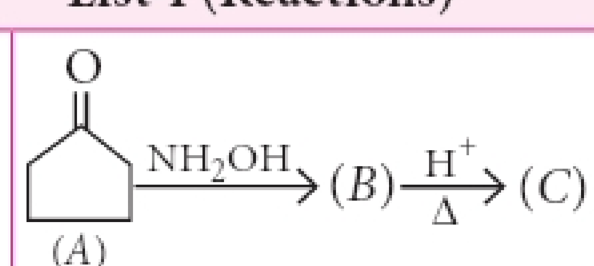
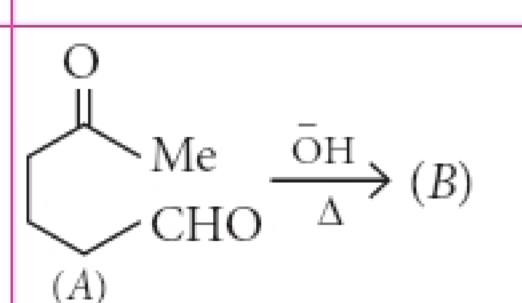
(c) IV → P, S (d) IV → P, Q

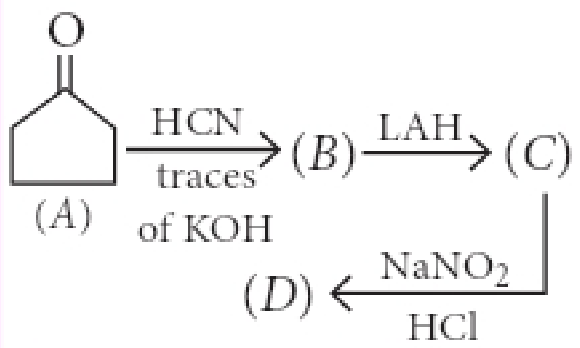
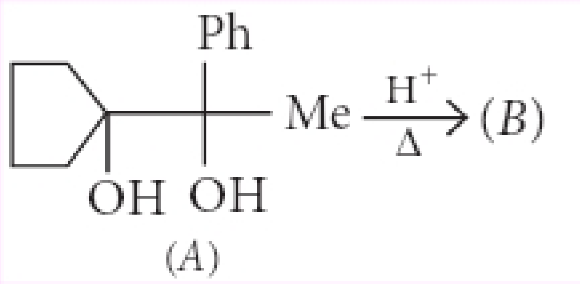
Answer Q. 17 and Q. 18 by appropriately matching the lists based on the information given in the paragraph.

Oximes of carbonyl compound undergo a rearrangement in the presence of mineral acids or Lewis acids to give substituted amides which on hydrolysis gives carboxylic acid and amines such phenomenon is called as Beckmann rearrangement.

Pinacol-pinacolone rearrangement is a method for converting a 1, 2-diol to a carbonyl compound in organic chemistry. The 1, 2-rearrangement takes place under acidic condition.

Brady's test : 2, 4-Dinitrophenylhydrazine can be used to detect the carbonyl functionality of a ketone or aldehyde functional group. A positive test is signalled by the formation of a yellow, orange or red precipitate.

List-I (Reactions)		List-II (Products)	
I.		(P)	Final product is α, β-unsaturated ketone.
II.		(Q)	Formation of six-membered ring takes place.

III.		(R)	Final product gives positive test with Brady's reagent.
IV.		(S)	Ring expansion takes place.

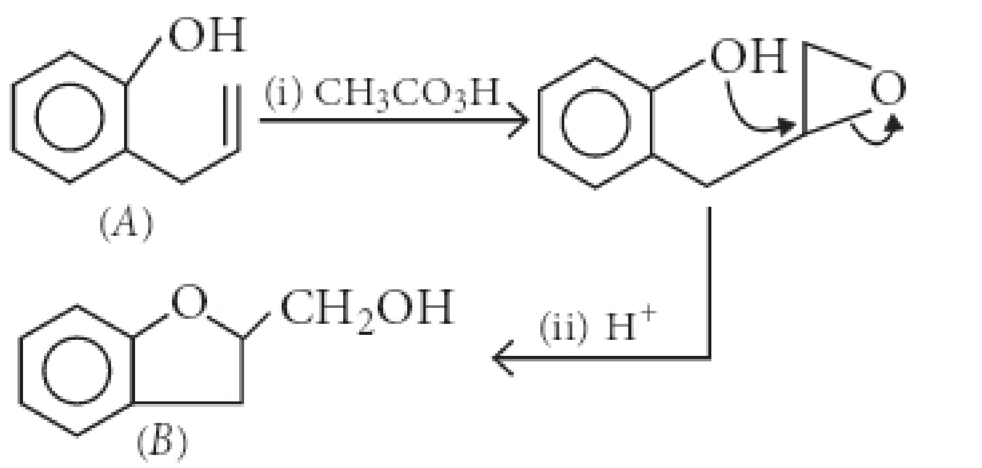
17. Which of the following options has the correct combination considering List-I and List-II?
(a) I → P, Q, S
(b) II → P, Q, R
(c) III → P, R, S
(d) IV → P, Q, R, S

18. Which of the following options has the correct combination considering List-I and List-II?
(a) I → P, R, S (b) II → P, Q, S
(c) III → Q, R, S (d) IV → P, S, R

SOLUTIONS

PAPER - I

1. (c) :



2. (b) : Number of N_2 molecules

$$= \frac{8.15}{22400} \times 6.023 \times 10^{23} = 2.19 \times 10^{20}$$

Total area occupied by these molecules

$$= 2.19 \times 10^{20} \times 16 \times 10^{-22} = 0.35 \text{ m}^2/\text{g}$$

3. (c) : $\lambda_{n,\,Z} \propto \frac{n}{Z}$

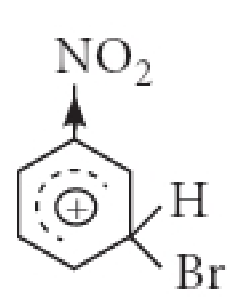
$$\lambda_{n+1,\,Z} + \lambda_{n-1,\,Z} = \lambda_0\left(\frac{n+1}{Z} + \frac{n-1}{Z}\right) = \left(\frac{2n}{Z}\right)\lambda_0$$

Thus, $\frac{2n}{Z} = 3$, which is according to option (c) *i.e.*, $Z = 2$ and $n = 3$.

4. (c) : $\underset{\text{Peroxodi-sulphuric acid}}{H_2S_2O_8} + H_2O \longrightarrow \underset{\text{Peroxomono-sulphuric acid}}{H_2SO_5} + H_2SO_4$

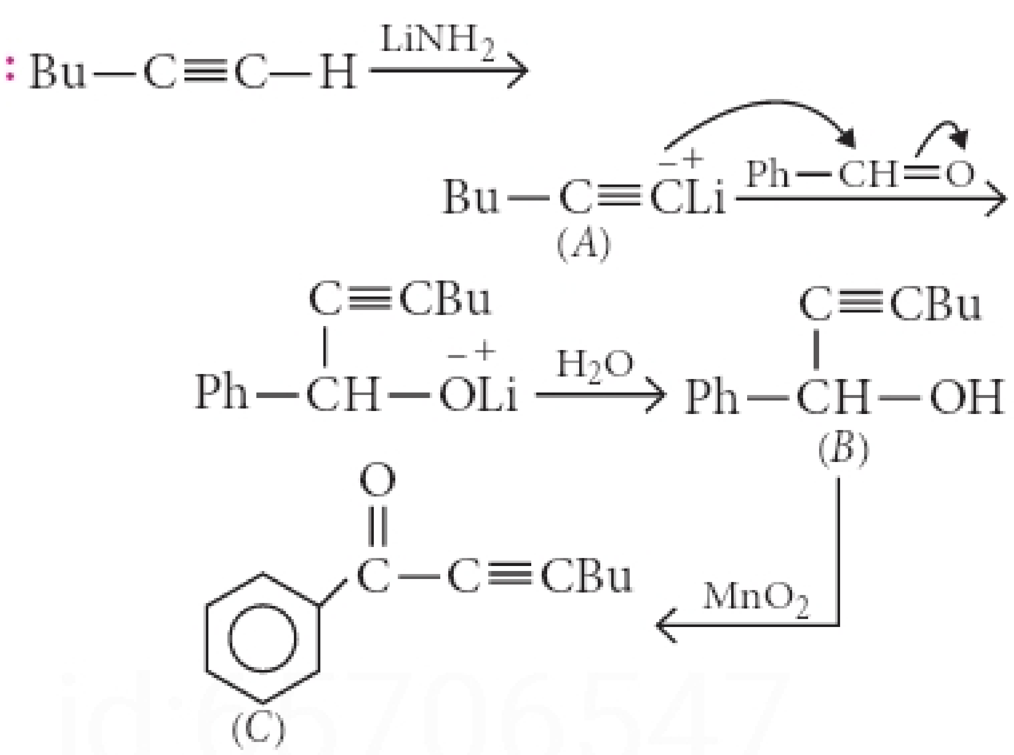
5. (a,b,c)

6. (d) : $-NO_2$ group decreases the density of electrons at *ortho* and *para* as compared to that at *meta* position. This is because of $-I$ and $-M$ effects of groups.



The Br^+ electrophile, will now attack at e^- rich site (*meta* position). The intermediate formed is a resonance hybrid of three structures so it is more stable than the corresponding intermediates from *ortho*-and-*para* attack.

7. (d) :



8. (a, d) : When a solute is added to a solvent there occurs a depression in freezing point of solvent.
Raoult's law states, "when a non-volatile solute is added to a solvent, the vapour pressure of the solvent decreases". At freezing point only the solvent molecules will solidify.

9. (a,b) : No of moles of $Na_2S_2O_3 = \frac{0.158}{158} = 10^{-3}$

I. $0.1 \times V_1 \times 3 = 10^{-3} \times 8$

II $0.1 \times V_2 \times 6 = 10^{-3} \times 8$

III. $0.1 \times V_3 \times 2 = 10^{-3} \times 1$

10. (a,c,d) : The crystals of CsCl has *bcc* structure. In such an arrangement the coordination number of both is 8.
In case of NaCl, two interpenetrating *fcc* crystal lattices are present, out of these, two are composed of Na^+ only and the other of Cl^- ions only. Each Na^+ ion is located half-way between two Cl^- ions and each Cl^- ion is located half-way between two Na^+ ions. In a unit cell of NaCl, Cl^- occupy corners as also the face centres and Na^+ ions are located at octahedral voids. On each of a unit cell we have two Cl^- ions and one Na^+ ion. Hence,
$a = 2\,(r_{Na^+} + r_{Cl^-}) = 2\,(95 + 181)\text{ pm} = 552\text{ pm}$

11. (b, c) : Fe^{2+} ions give blue ppt. with $K_3[Fe(CN)_6]$. The blue ppt. appears due to the formation of Turnbull's blue; $KFe[Fe(CN)_6]$.

$$Fe^{2+} + K_3[Fe(CN)_6] \longrightarrow \underset{\text{Potassium ferro-ferricyanide (Turnbull's blue)}}{KFe[Fe(CN)_6]} + 2K^+$$

The red colouration that appears in case of Fe^{3+} ions on reaction with potassium thiocyanate (KCNS) is due to formation of $[Fe(CNS)_3]$.

$$Fe^{3+} + 3KCNS \longrightarrow \underset{\text{Ferric thiocyanate (red)}}{[Fe(CNS)_3]} + 3K^+$$

12. (a,b) : $Na_2CO_3 \xrightarrow{\Delta}$ No reaction

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$

$K_2CO_3 \xrightarrow{\Delta}$ No reaction

$$MgCO_3 \xrightarrow{\Delta} MgO + CO_2$$

$$Ca(NO_3)_2 \xrightarrow{\Delta} CaO + 2NO_2 + \frac{1}{2}O_2$$

$$NaNO_3 \xrightarrow{\Delta} NaNO_2 + \frac{1}{2}O_2$$

$$MgCl_2\cdot 6H_2O \xrightarrow{\Delta} Mg(OH)Cl + HCl + 5H_2O$$

$$CaCl_2\cdot 6H_2O \xrightarrow{\Delta} CaCl_2 + 6H_2O$$

13. (282) : $k_1 = k_2$

$$\Rightarrow A_1e^{-E_1/RT} = A_2e^{-E_2/RT}$$

$$-\frac{152.3\times 10^3}{8.314\times T} = 2.3 - \frac{157.7\times 10^3}{8.314\times T} \Rightarrow T = 282 \text{ K}$$

14. (8)

15. (120) : $G^* = \frac{l}{A} = \frac{1.5}{5}\text{ cm}^{-1}$

$$\kappa = \frac{G^*}{R} = \frac{1.5}{5}\times\frac{1}{50}\,\Omega^{-1}\text{ cm}^{-1}$$

$$\Lambda_{eq} = \frac{1.5}{5}\times\frac{1}{50}\times\frac{1000}{0.05} = 120\,\Omega^{-1}\text{ cm}^2\text{eq}^{-1}$$

16. (65.25) : From Raoult's law, $\frac{p^\circ - p_s}{p^\circ} = \frac{w/m}{\frac{w}{m}+\frac{W}{M}}$

Given $p^\circ = 640$ mm Hg; $w = 2.175$ g; $m = ?$
$p_s = 600$ mm Hg; $w = 39.0$ g; $M = 78$
Substituting the given values, we get

$$\frac{640-600}{640} = \frac{\frac{2.175}{m}}{\frac{2.175}{m}+\frac{39}{78}}$$

or $\frac{40}{640} = \frac{2.175}{2.175+0.5\,m}$ or $m = 65.25$

17. (10) : $P_1 = 75$ cm

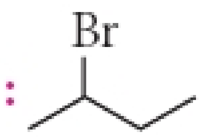
$V_1 = 12\,A$

$P_2 = P_{atm} + P_{Hg} + P_{oil}$

$$75 + 10 + \frac{6.8\times 10}{13.6} = 90 \text{ cm}$$

$V_2 = l\times A;\ P_1V_1 = P_2V_2$

$\Rightarrow 75\times 12A = 90\times l\times A;\ l = 10$ cm

18. (3) :  $Br + 2NaNH_2 \xrightarrow{-2HBr}$

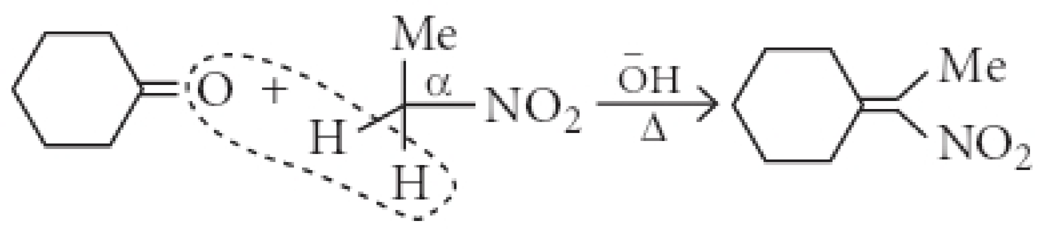
$$Me{-}C{\equiv}CH + 2NaBr + 2NH_3$$

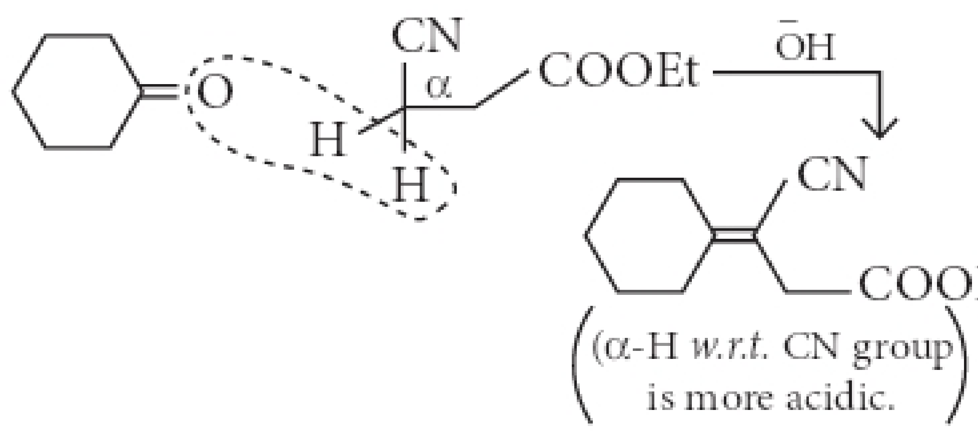
$$\xrightarrow{NaNH_2} Me{-}C{\equiv}C^-Na^+ + NH_3 \xrightarrow{C_2H_5Br} \underset{\text{Pent-2-yne}}{Me{-}C{\equiv}C{-}C_2H_5} + NaBr$$

PAPER - II

1. **(b, c, d) :** Chalcocite : Cu_2S; Copper pyrites : $CuFeS_2$
   Bauxite : $Al_2O_3 \cdot 2H_2O$; Corundum : Al_2O_3
   Anglesite : $PbSO_4$; Cerussite : $PbCO_3$
   Magnesite : $MgCO_3$; Cerussite : $PbCO_3$

2. **(a, c) :**

(a) 

(c) 

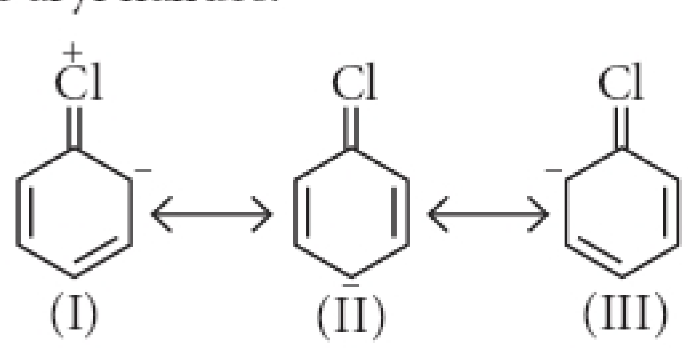
3. **(a, b, d):** $4NaCl + K_2Cr_2O_7 + 6H_2SO_4 \longrightarrow 2CrO_2Cl_2$ (Red vapours) $+ 4NaHSO_4 + 2KHSO_4 + 3H_2O$

CrO_2Cl_2 (Red vapours) $+ 4NaOH \longrightarrow Na_2CrO_4$ (Yellow solution) $+ 2NaCl + 2H_2O$

4. **(a, b, c) :** (*A*) with pI = 1.1, is in a very acidic range so, it has more anionic groups at pH = 7 and will migrate to the positive electrode (cathode). (*B*) with pI = 6.7 is present mostly with net zero charge and moves very little or will not migrate. (*C*) with pI = 11.0, is very basic protein, exists mainly in the cationic form and migrates to the negative electrode (anode). At pI = 7, amino acids have least solubilities, so (*B*) (pH = 6.7, very close to pH of the mixture *i.e.*, pH = 7), is least soluble and would precipitate out, while (*A*) and (*C*) would remain in the solution.

5. **(a)**

6. **(b, d)** : The resonating structures I, II and III stabilise the aryl halides.



These structures include a double bond between C and Cl.

The sp^2 hybridised carbon makes the C – Cl bond shorter and stronger.

7. **(b, d) :** $\left[\dfrac{PV}{(T+x)}\right]_1 = \left[\dfrac{PV_m}{(T+x)}\right]_2$

$$\frac{20}{(30+x)} = \frac{40}{(300+x)}$$

$300 + x = 60 + 2x$

$x = 240 \Rightarrow 0\ K = -240°C$

$$R = \frac{PV_m}{T+x} = \frac{20}{270} = 0.0741 \text{ L-atm/K-mol}$$

8. **(d) :** Glucose is not an electrolyte and it remains undissociate thus it gives only one particle which is the minimum number of particles, hence it has minimum ΔT_f or maximum freezing point.

9. **(6) :** Decapeptide + 9 $H_2O \longrightarrow$ Glycine + Alanine + Phenylalanine.

Total wt. of amino acids after addition of 9 mol of H_2O
$= 796 + (9 \times 18) = 958$

For *n*-units of glycine, $\dfrac{n \times 75}{958} \times 100 = 47 \Rightarrow n = 6$

10. **(2) :** The change in oxidation state of *A* when A^{n+} is oxidised to AO_3^- in acidic medium is from $+n$ to $(+5)$ *i.e.*, the change is equal to $(5 - n)$.

The number of electrons added to reduce 1.61×10^{-3} moles of MnO_4^- to Mn^{2+}
(O.S. of Mn changes from +7 to + 2)

$\therefore\ 1.61 \times 10^{-3} \times 5 = 2.68 \times 10^{-3}\,(5 - n)$

or $(5 - n) = \dfrac{1.61 \times 10^{-3} \times 5}{2.68 \times 10^{-3}}$

or $5 - n = 3$ or $n = 2$

11. **(4.76) :** Weight of gold deposited in first cell = 9.85 g
Atomic weight of gold = 197
Oxidation number of gold = +3

$\therefore$ Equivalent weight of gold $= \dfrac{197}{3}$

Using the relation, $W = z.\ i.\ t.$ we get

Charge required to deposit 1g eq. (197/3) of gold

$$= 1F = 96500 \text{ coulombs}$$

$\therefore$ Charge required to deposit 9.85 g of gold

$$= \frac{1}{197/3} \times 9.85 \text{ F}$$

$$= \frac{3 \times 9.85}{197} \times 96500\text{C} = 14475\text{C}$$

Amount of copper deposited at cathode in second cell :

From Faraday's second law, we have

$$\frac{\text{Weight of Cu}}{\text{Weight of Au}} = \frac{\text{Eq. wt. of Cu}}{\text{Eq. wt. of Au}}$$

or weight of Cu $= \dfrac{9.85 \times 63.5 \times 3}{197 \times 2} = 4.7625\text{g}$

12. (900) : $NH_4I_{(s)} \rightleftharpoons NH_{3(g)} + HI_{(g)}$

300 mm Hg 150 mm Hg 150 mm Hg

$K_p = K_c = 150 \times 150$ ...(i)

$HI \rightleftharpoons \frac{1}{2}H_2 + \frac{1}{2}I_2$

$150 - P$ $\frac{P}{2}$ $\frac{P}{2}$

$$\Rightarrow \frac{P/2}{150 - P} = 2 = K_p$$

From eq. (i), $5P = 600$, $P = 120$

$\therefore\ P_{HI} = 150 - 120 = 30$

$150 \times 150 = P_{NH_3} \times 30 \Rightarrow P_{NH_3} = 750$ mm of Hg

Total $P = P_{NH_3} + P_{HI} + P_{H_2} + P_{I_2}$

$= 750 + 30 + 60 + 60 = 900$ mm of Hg

13. (–16.11) : $C_6H_{12}O_{6(s)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)}$

$\Delta H_c^\circ = \Sigma\Delta H_f^\circ{}_{(\text{products})} - \Sigma\Delta H_f^\circ{}_{(\text{reactants})}$

$= [6 \times \Delta H_f^\circ(CO_2) + 6 \times \Delta H_f^\circ(H_2O)] - [\Delta H_f^\circ(C_6H_{12}O_6) + 6 \times \Delta H_f^\circ(O_2)]$

$= [6 \times (-400) + 6\,(-300)] - [-1300 + 6(0)]$

$= [(-2400 - 1800] - [-1300] = -4200 + 1300$

$= -2900$ kJ/mol

The standard enthalpy of combustion per gram of glucose is $= \dfrac{-2900}{180} = -16.11$ kJ/g

14. (5) : (i) TiO, Sc_2O_3, Ti_2O_3, VO and CuO (Basic)

(ii) CrO_3 (Acidic)

(iii) Cr_2O_3, TiO_2 and V_2O_5 (Amphoteric)

15. (c) : III $\rightarrow$ Q, S

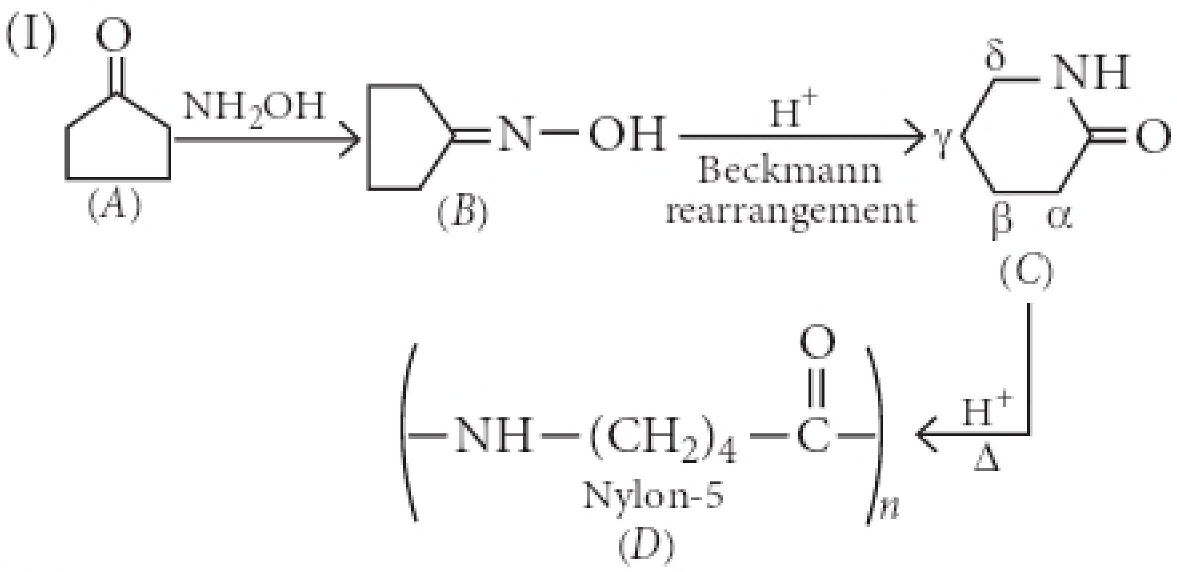
16. (b) : II $\rightarrow$ P, R

17. (b) : II $\rightarrow$ P, Q, R

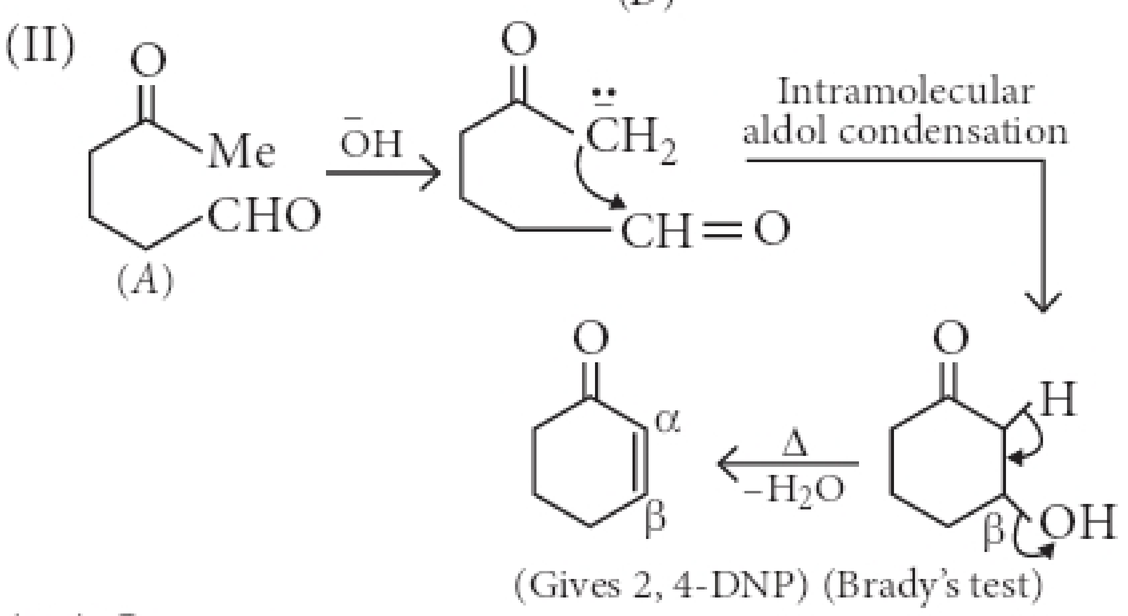
18. (c) : III $\rightarrow$ Q, R, S

Explanation :

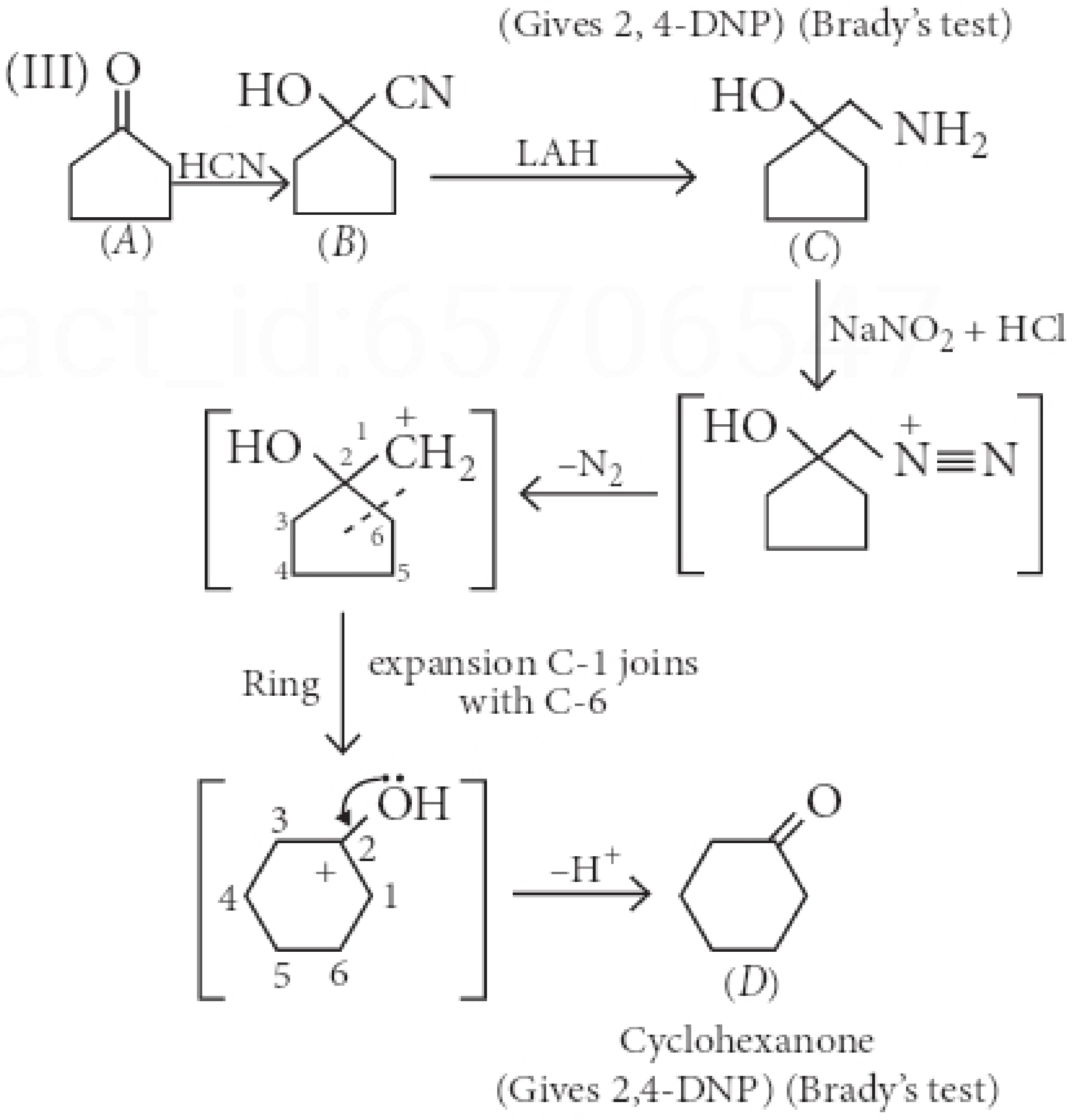
(I)



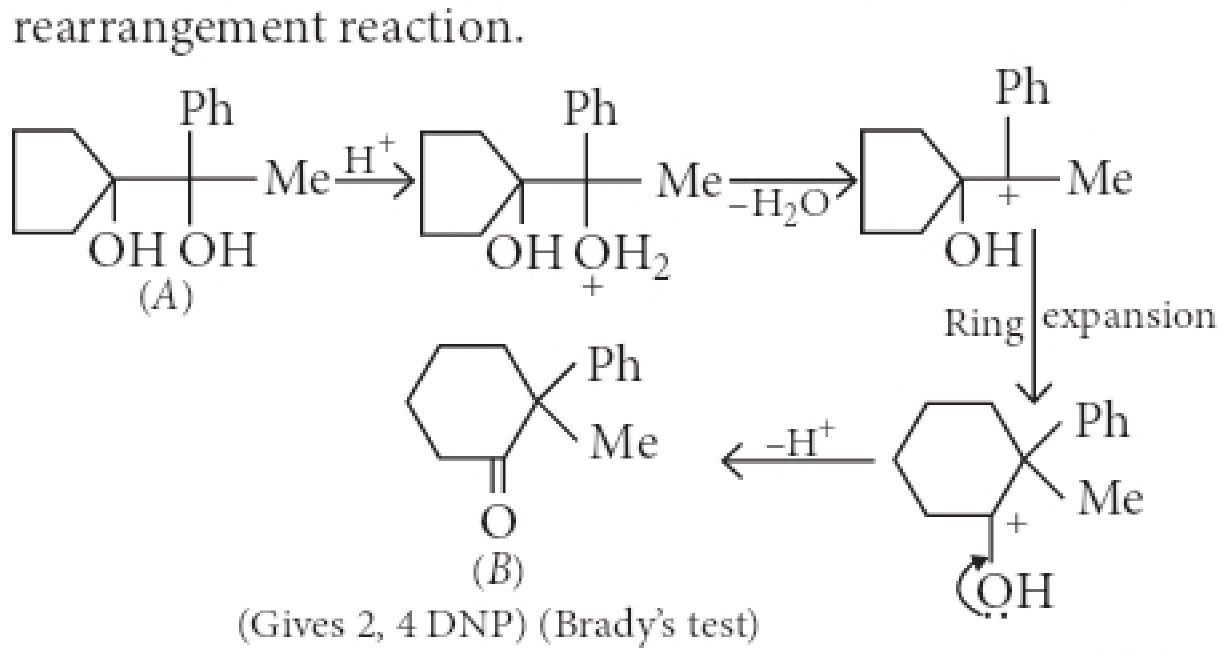
(II)



(III)



(IV) : It is an example of Pinacol-Pinacolone rearrangement reaction.



PRACTICE PAPER

NEET

Exam on
3rd May 2020

1. $R - CH_2 - CH_2 - OH$ can be converted into RCH_2CH_2COOH by the following sequence of steps
(a) PBr_3, KCN, H_3O^+ (b) PBr_3, KCN, H_2/Pt
(c) KCN, H_3O^+ (d) HCN, PBr_3, H_3O^+

2. In borax, the number of B—O—B links and B—OH bonds present are, respectively
(a) five and four (b) four and five
(c) three and four (d) five and five.

3. Optically active compounds among the following are
(i) 1-phenylethanol (ii) 2-phenylpropan-1-ol
(iii) 2-phenylpropan-2-ol (iv) 2-methylpropan-2-ol
(a) (ii) and (iii) (b) (i) and (ii)
(c) (iii) and (iv) (d) (ii) and (iv).

4. $xMnO_4^- + yH_2SO_4 \rightarrow 2Mn^{2+} + 5H_2O + 9O_2 + ze^-$
In this reaction values of x, y and z are
(a) 2, 5, 6 (b) 5, 2, 9 (c) 3, 5, 5 (d) 2, 6, 6.

5. Each rubidium halide crystallising in the NaCl type lattice has a unit cell length 0.30 Å greater than that for corresponding potassium salt ($r_{(K^+)}$ = 1.33 Å) of the same halogen. Hence, ionic radius of Rb^+ is
(a) 1.18 Å (b) 1.48 Å (c) 1.63 Å (d) 1.03 Å.

6. For alkali metals, which one of the following trends is incorrect?
(a) Hydration energy : Li > Na > K > Rb
(b) Ionization energy : Li > Na > K > Rb
(c) Density : Li < Na < K < Rb
(d) Atomic size : Li < Na < K < Rb

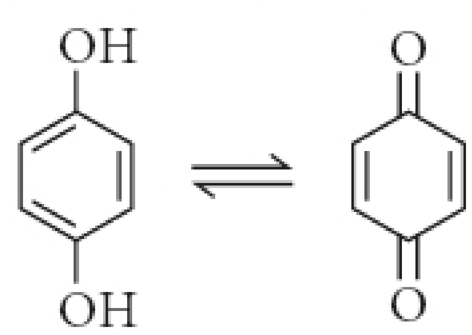
7. The enthalpy of neutralization of a strong acid by a strong base is –57.32 kJ mol^{-1}. The enthalpy of formation of water and hydrogen ion are –285.84 kJ mol^{-1} and 0 kJ mol^{-1} respectively. The enthalpy of formation of hydroxyl ion is
(a) 228.52 kJ mol^{-1} (b) –114.26 kJ mol^{-1}
(c) –228.52 kJ mol^{-1} (d) 114.2 kJ mol^{-1}.

8. A jeweller is selling 22-carat gold articles with 95% purity, it is approximately
(a) exact (b) 3.33% higher
(c) 3.33% lower (d) 5% lower.

9. The electronic configuration of the element with atomic number 107 and the group number in the periodic table in which it lies are
(a) [Rn] $5f^{14}6d^1 7s^2 7p^4$, Group 3
(b) [Rn] $5f^{14}6d^5 7s^2$, Group 7
(c) [Rn] $5f^{14}7s^2 7p^5$, Group 7
(d) [Rn] $5f^{14}6d^2 7s^2 7p^3$, Group 15.

10. Permanent hardness is due to presence of soluble salts of magnesium and calcium in the form of chlorides and sulphates in water. Permanent hardness of water can be removed by
(a) boiling (b) Clark's method
(c) treatment with sodium carbonate
(d) none of these.

11. For the half-cell,



$+ 2H^+ + 2e^-$; $E° = 1.30$ V

At pH = 2, electrode potential is
(a) 1.36 V (b) 1.30 V (c) 1.42 V (d) 1.20 V

12. The electrons, identified by quantum numbers n and l, (i) $n = 4, l = 1$, (ii) $n = 4, l = 0$, (iii) $n = 3, l = 2$, and (iv) $n = 3, l = 1$ can be placed in order of increasing energy, from the lowest to highest, as
(a) (iv) < (ii) < (iii) < (i)
(b) (ii) < (iv) < (i) < (iii)
(c) (i) < (iii) < (ii) < (iv)
(d) (iii) < (i) < (iv) < (ii)

13. 1-Propanol and 2-propanol can be distinguished by
(a) oxidation with alkaline $KMnO_4$ followed by reaction with Fehling solution
(b) oxidation with acidic dichromate followed by reaction with Fehling solution
(c) oxidation by heating with copper followed by reaction with Fehling solution
(d) oxidation with conc. H_2SO_4 followed by reaction with Fehling solution.

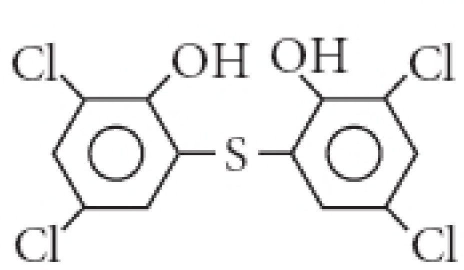
14. Among the following carbocations :
(I) $Ph_2\overset{+}{C}CH_2Me$ (II) $PhCH_2CH_2\overset{+}{C}HPh$
(III) $Ph_2CH\overset{+}{C}HMe$ (IV) $Ph_2C(Me)\overset{+}{C}H_2$
the order of stability is
(a) IV > II > I > III (b) I > II > III > IV
(c) II > I > IV > III (d) I > IV > III > II

15. What does green chemistry mean in terms of environment?
(a) Greenhouse effect
(b) Reactions related to depletion of ozone layer
(c) Photosynthetic reactions in plants
(d) Reduction in the use and production of hazardous chemicals

16. Which one of the following statements is not true?
(a) Buna-S is a copolymer of butadiene and styrene.
(b) Natural rubber is a 1, 4-addition polymer of isoprene.
(c) In vulcanization, the formation of sulphur bridges between different chains makes rubber harder and stronger.
(d) Natural rubber has the *trans*-configuration at every double bond.

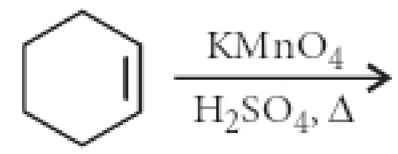
17. Which of the following will not be oxidized by ozone?
(a) KI (b) $FeSO_4$
(c) $KMnO_4$ (d) K_2MnO_4

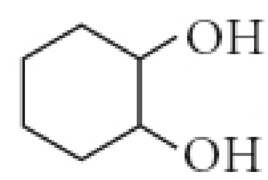
18. $H_3PO_4 + H_2O \rightleftharpoons H_3O^+ + H_2PO_4^-$; $pK_1 = 2.15$
$H_2PO_4^- + H_2O \rightleftharpoons H_3O^+ + HPO_4^{2-}$; $pK_2 = 7.20$
Hence, pH of 0.01 M NaH_2PO_4 is
(a) 9.35 (b) 4.675 (c) 2.675 (d) 7.350

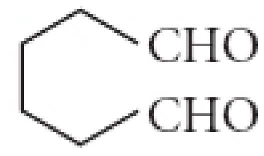
19. 

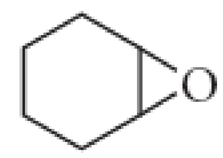
serves as a/an
(a) disinfectant (b) antibiotic
(c) antiseptic (d) analgesic.

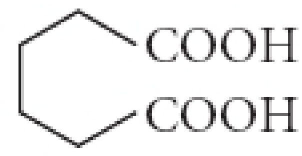
20. The final product in the given reaction is



(a) 

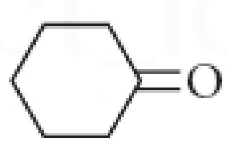
(b) 

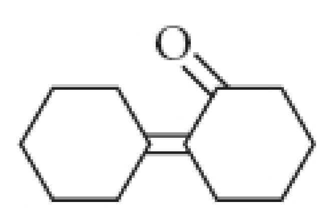
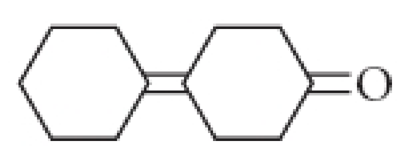
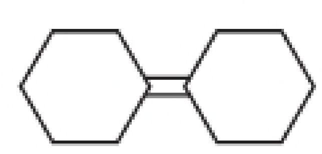
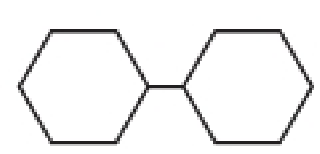
(c) 

(d) 

21. In the reaction, $2N_2O_5 \longrightarrow 4NO_2 + O_2$, initial pressure and rate constant, k are 500 atm and 3.38×10^{-5} sec^{-1} respectively. After 10 minutes, the final pressure of N_2O_5 is
(a) 490 atm (b) 250 atm
(c) 480 atm (d) 420 atm.

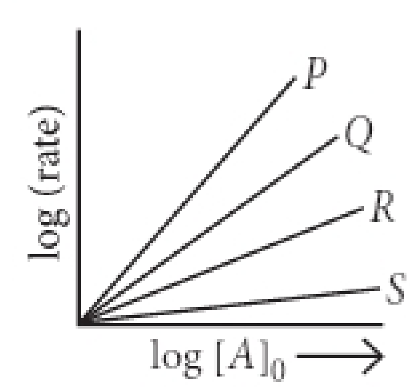
22. The reaction of toluene with Cl_2 in presence of $FeCl_3$ gives X and reaction in presence of light gives Y. Thus X and Y are
(a) X = benzyl chloride, Y = *m*-chlorotoluene
(b) X = benzal chloride, Y = *o*-chlorotoluene
(c) X = *m*-chlorotoluene, Y = *p*-chlorotoluene
(d) X = *o*- and *p*-chlorotoluene, Y = trichloromethylbenzene

23.  $\xrightarrow[\text{(aldol)}]{\text{NaOH, }\Delta}$ A, A can be

(a) 
(b) 
(c) 
(d) 

24. For n^{th} order reaction, $\left(\frac{dx}{dt}\right) = \text{Rate} = k[A]_0^n$
Graph between log (rate) against log $[A]_0$ is of the type, lines P, Q, R and S are for the order

	P	Q	R	S
(a)	0	1	2	3
(b)	3	2	1	0
(c)	1	2	3	0
(d)	0	3	2	1



25. Which of the following is the correct increasing order of basicity of amines in gaseous phase?
(a) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$
(b) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2 > NH_3$
(c) $(CH_3)_2NH > (CH_3)_3N > CH_3NH_2 > NH_3$
(d) $(CH_3)_3N > CH_3NH_2 > (CH_3)_2NH > NH_3$

26. An ideal solution of benzene and toluene boils at 1 atm pressure at 90 °C. At 90 °C, benzene has a vapour pressure of 1022 mm of Hg and toluene has a vapour pressure of 406 mm of Hg. The mole fraction of benzene in the solution is
(a) 0.284 (b) 0.364 (c) 0.575 (d) 0.475

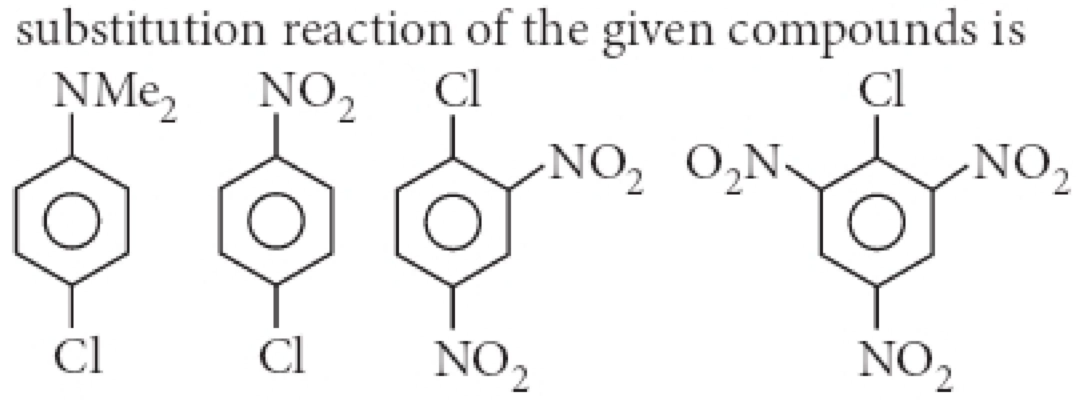
27. Molecular shapes of SF_4, CF_4 and XeF_4 are
(a) the same, with 2, 0 and 1 lone pairs of electrons respectively
(b) the same, with 1, 1 and 2 lone pairs of electrons respectively
(c) different, with 0, 1 and 2 lone pairs of electrons respectively
(d) different, with 1, 0 and 2 lone pairs of electrons respectively.

28. In van der Waals' equation of state for a non-ideal gas, the term that accounts for intermolecular forces is
(a) $(V - b)$ (b) RT
(c) $\left(P + \frac{a}{V^2}\right)$ (d) $(RT)^{-1}$

29. The IUPAC name of the complex, $[Co(NH_3)_4(H_2O)Cl]Cl_2$ is
(a) aquatetramminechloridocobalt(III) chloride
(b) chloridoaquatetramminechloridocobalt(II) chloride
(c) aquatetramminechloridocobalt(II) chloride
(d) tetraammineaquachloridocobalt(III) chloride.

30. Purest form of silica is
(a) quartz (b) flint
(c) sandstone (d) keiselguhr.

31. Correct order of reactivity towards nucleophilic substitution reaction of the given compounds is



(i) (ii) (iii) (iv)

(a) i > ii > iii > iv (b) ii > i > iii > iv
(c) iv > iii > ii > i (d) iii > iv > ii > i

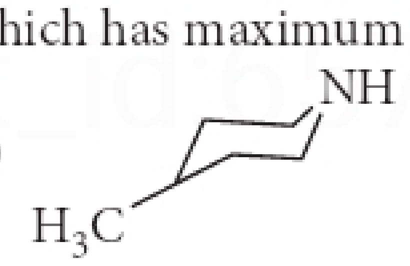
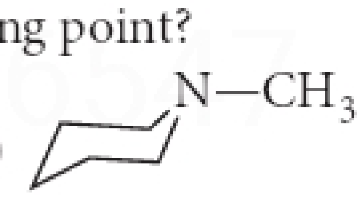
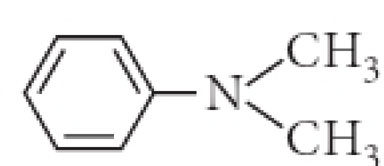
32. What happens when gelatin is added to gold sol?
(a) Gold sol is destabilised and peptisation occurs.
(b) Gold sol is stabilised and no coagulation takes place.
(c) Gold sol is destabilised and coagulation takes place.
(d) Gold sol is stabilised and peptisation takes place.

33. Sulphur reacts with chlorine in 1 : 2 ratio and forms *X*. Hydrolysis of *X* gives a sulphur compound *Y*. What is the structure and hybridization of anion of *Y*?
(a) Tetrahedral, sp^3 (b) Linear, sp
(c) Pyramidal, sp^3 (d) Trigonal planar, sp^2

34. 0.58 g of hydrocarbon on combustion gave 0.9 g of water. The percentage of carbon is about
(a) 75.8 (b) 82.7 (c) 27.85 (d) 68.8

35. Which of the following reactions is not involved in thermite process?
(a) $3Mn_3O_4 + 8Al \longrightarrow 9Mn + 4Al_2O_3$
(b) $Cr_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Cr$
(c) $2Fe + Al_2O_3 \longrightarrow 2Al + Fe_2O_3$
(d) $B_2O_3 + 2Al \longrightarrow 2B + Al_2O_3$

36. Which is false statement about LCAO?
(a) Addition of atomic orbitals result in molecular orbitals.
(b) Atomic orbitals of nearly same energy combine to form molecular orbitals.
(c) Bonding molecular orbitals occupy higher energy than atomic orbitals.
(d) Each molecular orbital accommodates maximum number of two electrons.

37. Which has maximum boiling point?
(a)  (b) 
(c) $(CH_3)_3N$ (d) 

38. Which of the following does not decrease with rise in temperature?
(a) Density (b) Surface tension
(c) Vapour pressure (d) Viscosity

39. Which of the following pairs form the same osazone?
(a) Glucose and fructose (b) Glucose and galactose
(c) Glucose and arabinose
(d) Lactose and maltose

40. The following two reactions are known,
$Fe_2O_{3(s)} + 3CO_{(g)} \longrightarrow 2Fe_{(s)} + 3CO_{2(g)}$; $\Delta H = -26.8$ kJ
$FeO_{(s)} + CO_{(g)} \longrightarrow Fe_{(s)} + CO_{2(g)}$; $\Delta H = -16.5$ kJ
The value of ΔH for the following reaction,
$Fe_2O_{3(s)} + CO_{(g)} \longrightarrow 2FeO_{(s)} + CO_{2(g)}$ is
(a) + 10.3 kJ (b) – 43.3 kJ
(c) – 10.3 kJ (d) + 6.2 kJ.

41. In which of the following there is outer orbital hybridization?
(a) $[MnF_6]^{3-}$ (b) $[Co(NH_3)_6]^{3+}$
(c) $[Cr(NH_3)_6]^{3+}$ (d) $[Mn(CN)_6]^{4-}$

42. The solubility product of a sparingly soluble salt AB at room temperature is 1.21×10^{-6}. Its molar solubility is
(a) 1.1×10^{-3} mol L^{-1} (b) 1.21×10^{-6} mol L^{-1}
(c) 1.01×10^{-3} mol L^{-1} (d) 1.1×10^{-4} mol L^{-1}.

43. Which of the following expressions correctly represents the equivalent conductance at infinite dilution of $Al_2(SO_4)_3$. Given that $\lambda^\circ_{Al^{3+}}$ and $\lambda^\circ_{SO_4^{2-}}$ are the equivalent conductances at infinite dilution of the respective ions?
(a) $2\lambda^\circ_{Al^{3+}} + 3\lambda^\circ_{SO_4^{2-}}$ (b) $\lambda^\circ_{Al^{3+}} + \lambda^\circ_{SO_4^{2-}}$
(c) $(\lambda^\circ_{Al^{3+}} + \lambda^\circ_{SO_4^{2-}}) \times 6$ (d) $\frac{1}{3}\lambda^\circ_{Al^{3+}} + \frac{1}{2}\lambda^\circ_{SO_4^{2-}}$

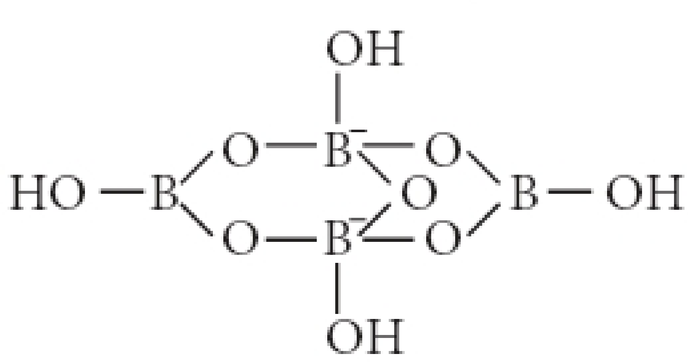
44. When 1 L of CO_2 is heated with graphite, the volume of the gases collected is 1.5 L. What would be the number of moles of CO produced at S.T.P.?
(a) $\frac{1}{11.2}$ (b) $\frac{28}{22.4}$ (c) $\frac{1}{22.4}$ (d) $\frac{14}{22.4}$

45. Formaldehyde + Ammonia $\rightarrow$ Urotropine + $6H_2O$
The formula of urotropine is
(a) hexamethylenetetraamine
(b) tetramethylenetetraamine
(c) hexamethylenehexaamine
(d) none of these.

SOLUTIONS

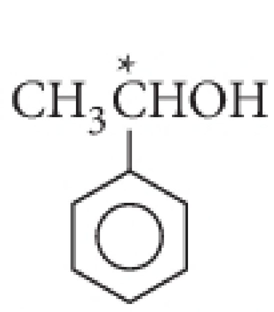
1. (a) : $RCH_2CH_2OH \xrightarrow{PBr_3} RCH_2CH_2Br \xrightarrow{KCN} RCH_2CH_2CN \xrightarrow[\text{or } H_3O^+]{H_2O/H^+} RCH_2CH_2COOH$

2. (a) :

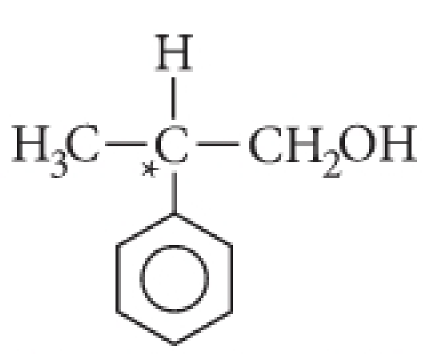


No. of B—O—B links = 5
No. of B—OH links = 4

3. (b) :



1-Phenylethanol



2-Phenylpropan-l-ol

4. (a)

5. (b) : There is increase in 0.30 Å unit length. This is due to two atoms at the corners.

Thus, $r_{Rb^+} = 1.33\ \text{Å} + \frac{0.30\ \text{Å}}{2} = 1.48\ \text{Å}$

6. (c) : Density gradually increases on moving down from Li to Cs. Potassium is, however, lighter than sodium. The abnormal value of potassium is due to unusual increase in atomic size, *i.e.*, atomic volume.

7. (c) : The enthalpy of neutralization is

$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}; \Delta H^\circ = -57.32$ kJ mol^{-1}

$\Delta H_{reaction} = \Sigma$ Heat of formation of products $- \Sigma$ Heat of formation of reactants

$= \Delta H^\circ_{f\,H_2O_{(l)}} - [\Delta H^\circ_{f\,(H^+)_{(aq)}} + \Delta H^\circ_{f\,(OH^-)_{(aq)}}]$

$-57.32 = -285.84 - (0 + x)$

$x = -285.84 + 57.32 = -228.52$ kJ mol^{-1}

8. (b) : 24 carat gold is 100%.

Thus, 22-carat gold $= \frac{22}{24} \times 100 = 91.67\%$

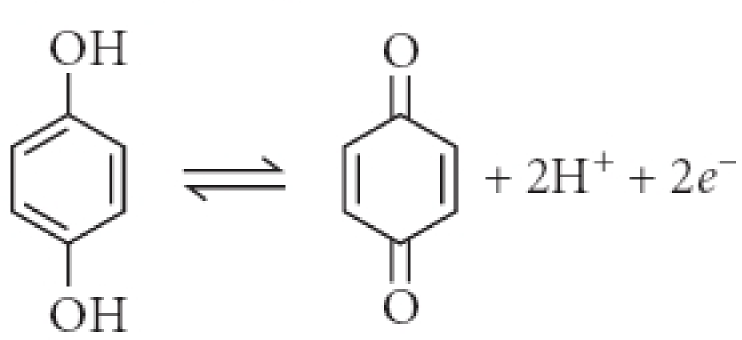
Purity $= 95 - 91.67 = 3.33\%$

Thus, 3.33% higher.

9. (b)

10. (c) : Water softners which are used to remove permanent hardness are washing soda (sodium carbonate), permutit, calgon, etc.

11. (c) : In this electrode,
$[A] = [B]$ in quinhydrone electrode



(A) (B)

Hence, $Q = [H^+]^2$

$E = E^\circ - \frac{0.0591}{2}\log[H^+]^2$

$= E^\circ - 0.0591 \log [H^+] = E^\circ + 0.0591$ pH

$= 1.30 + 0.0591 \times 2 \approx 1.42$ V

12. (a) **13. (c)**

14. (b) : Stability of carbocations depends upon number of resonating structures and extent of $+I$, $-I$-effect.

15. (d)

16. (d) : Natural rubber has the *cis*-configuration at every double bond.

17. (c) : $KMnO_4$ cannot be further oxidized by O_3. It has the highest +7 oxidation state of Mn in it. Alkaline KI is oxidised to potassium iodate and periodate.

$$KI + 3O_3 \longrightarrow \underset{\text{Pot. iodate}}{KIO_3} + 3O_2;\ KI + 4O_3 \longrightarrow \underset{\text{Pot. periodate}}{KIO_4} + 4O_2$$

It oxidises manganate to permanganate.

$$2K_2MnO_4 + H_2O + O_3 \longrightarrow 2KMnO_4 + 2KOH + O_2$$

Acidified ferrous sulphate is oxidized to ferric sulphate.

$$2FeSO_4 + H_2SO_4 + O_3 \longrightarrow Fe_2(SO_4)_3 + H_2O + O_2$$

18. (b) : $H_2PO_4^-$ is amphiprotic.

$$H_2PO_4^- + H_2O \rightleftharpoons H_3PO_4 + OH^-$$

$$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{2-} + H_3O^+$$

$$\therefore\ pH = \frac{pK_1 + pK_2}{2} = \frac{2.15 + 7.20}{2} = 4.675$$

19. (c) : The given structure is of bithional and it is used as an antiseptic.

20. (d) : In acidic medium $KMnO_4$ is a very powerful oxidising agent.

21. (a) : If P_t is the pressure after time t,

$$k = \frac{2.303}{t}\log\frac{P_0}{P_t}$$

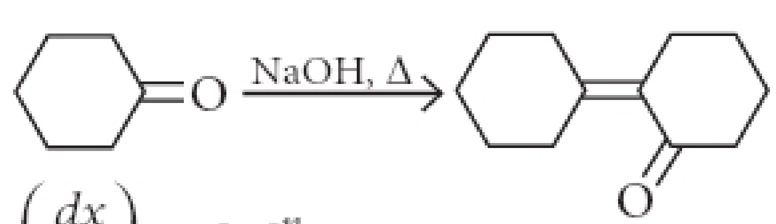
$$\therefore\ 3.38 \times 10^{-5}\ s^{-1} = \frac{2.303}{600\ s}\log\frac{500\ atm}{P_t}$$

or $\log\frac{500}{P_t} = 0.0088$ or $\frac{500}{P_t} = 1.02$

or $P_t = 490$ atm

22. (d)

23. (a) :



24. (b) : $\left(\frac{dx}{dt}\right) = k[A]_0^n$

$$\log\left(\frac{dx}{dt}\right) = n\log[A]_0 + \log k$$

Thus, n = slope = order

Greater the order, larger the slope

Thus, $P = 3, Q = 2, R = 1, S = 0$

25. (b)

26. (c) : $p_B^\circ = 1022$ mm of Hg; $p_T^\circ = 406$ mm of Hg

$$p_B^\circ x_B + p_T^\circ x_T = p_{Total}$$

$$1022x_B + 406(1 - x_B) = 1\ atm = 760\ mm$$

$$\therefore\ x_B = 0.575$$

27. (d) **28. (c)**

29. (d) **30. (a)**

31. (c) : Electron-withdrawing groups increases and electron-donating groups decrease the reactivity towards nucleophilic substitution.

32. (b)

33. (c) : $\underset{1:2}{S + 2Cl_2} \longrightarrow \underset{(X)}{SCl_4}$

$$\underset{(X)}{SCl_4} + 4H_2O \xrightarrow{\text{Hydrolysis}} \underset{\text{Unstable}}{S(OH)_4} + 4HCl$$

$$\downarrow$$

$$\underset{\text{Anion of }(Y)}{SO_3^{2-}} + 2H^+ \rightleftharpoons \underset{\substack{\text{Sulphurous acid}\\(Y)}}{H_2SO_3} + H_2O$$

Structure and hybridization of SO_3^{2-} is pyramidal and sp^3 respectively.

34. (b) : Percentage of H $= \frac{2}{18}\times\frac{0.9}{0.58}\times 100 = 17.24\%$

$\therefore$ Percentage of C = 100 – Percentage of H
= 100 – 17.24 = 82.7%

35. (c) **36. (c)**

37. (a) : Among the given molecules, 2° amine has maximum boiling point due to intermolecular H-bonding, others lacks active H for H-bonding.

38. (c) : Vapour pressure increases with rise in temperature.

39. (a)

40. (d) : $Fe_2O_{3(s)} + 3CO_{(g)} \longrightarrow 2Fe_{(s)} + 3CO_{2(g)};$
$\Delta H = -26.8$ kJ ...(i)

$FeO_{(s)} + CO_{(g)} \longrightarrow Fe_{(s)} + CO_{2(g)}; \Delta H = -16.5$ kJ...(ii)

$Fe_2O_{3(s)} + CO_{(g)} \longrightarrow 2FeO_{(s)} + CO_{2(g)}; \Delta H = ?$ ...(iii)

Eq (iii) can be obtained as (i) – 2(ii)

= –26.8 – 2(–16.5) = –26.8 + 33.0 = +6.2 kJ.

41. (a)

42. (a) : $\underset{S}{AB} \rightleftharpoons \underset{S}{A^+} + \underset{S}{B^-}$

$\Rightarrow$ Solubility product $= S \times S = S^2$

$\Rightarrow$ $S = \sqrt{K_{sp}} = \sqrt{1.21\times 10^{-6}} = 1.1 \times 10^{-3}$ mol L^{-1}

43. (b) : $\Lambda_{eq}^\infty[Al_2(SO_4)_3] = \lambda^\circ_{Al^{3+}} + \lambda^\circ_{SO_4^{2-}}$

44. (c) : $\underset{1-x}{CO_{2(g)}} + C_{(s)} \longrightarrow \underset{2x}{2CO_{(g)}}$

Total volume $= 1 - x + 2x = 1 + x = 1.5$

$\Rightarrow x = 0.5$ L

$\therefore$ Volume of CO $= 2 \times 0.5 = 1$ L

Number of moles of CO $= \frac{1}{22.4}$

45. (a) : $6HCHO + 4NH_3 \longrightarrow \underset{\substack{\text{Urotropine}\\\text{(Hexamethylene tetraamine)}}}{(CH_2)_6N_4} + 6H_2O$

GET SET GO for NEET

Exam on May 3, 2020



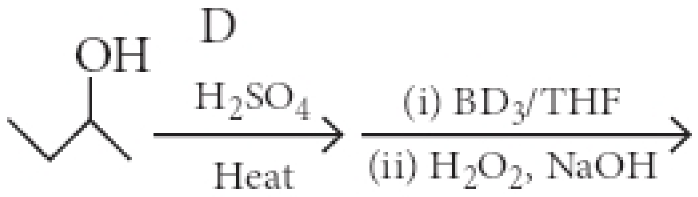
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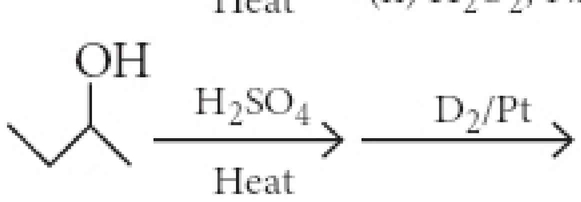
Practicing these MCQs help to strengthen your concepts and give you extra edge in your NEET preparation

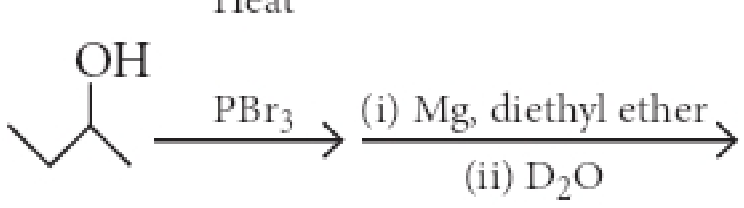
Only One Option Correct Type

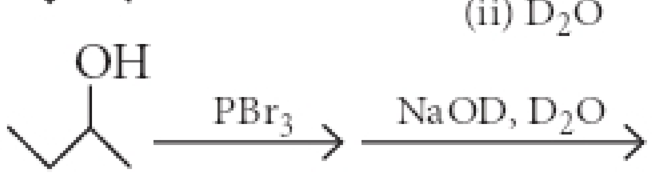
1. Which of the following reactions would convert 2-butanol into deuterated compound?

$CH_3-CH_2-CH(D)-CH_3$

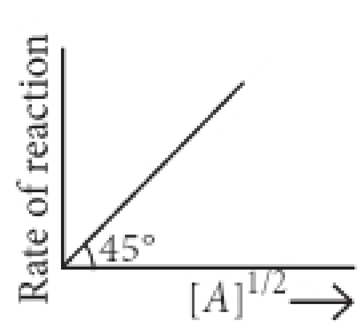
(a) 

(b) 

(c) 

(d) 

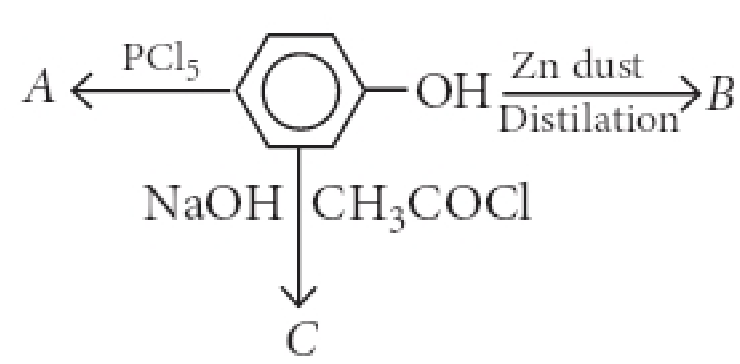
2. Rate of reaction $A \longrightarrow B$ depends only on A and can be represented by the following curve. Then which of the following statements is correct?



(a) The molecularity of reaction must be one.
(b) The reaction will be an elementary reaction.
(c) The value of rate constant for the reaction will be $M^{-1/2}\,sec^{-1}$.
(d) The reaction will definitely be a complex reaction.

3. When Cl_2-water is added to an aqueous solution of potassium halide in presence of $CHCl_3$ a violet colour is obtained. On adding more of Cl_2-water, the violet colour disappears and a colourless solution is obtained. This test confirms the presence of which of the following halides in aqueous solution?
(a) Bromide (b) Chloride
(c) Iodide and bromide (d) Iodide

4. The compounds A, B and C in the given reaction sequence are



(a) chlorobenzene, benzene and methyl benzoate
(b) triphenylphosphate, benzene and phenyl acetate
(c) benzyl chloride, benzene and phenyl acetate
(d) benzyl chloride, benzene and phenylacetyl chloride.

5. Which one of the following is used as an antihistamine?
(a) Omeprazole (b) Chloramphenicol
(c) Diphenylhydramine (d) Norethindrone

6. Consider the following aqueous solutions of electrolytes and assume 100% ionisation.
I. 0.1 m urea II. 0.04 m $Al_2(SO_4)_3$
III. 0.05 m $CaCl_2$ IV. 0.005 m NaCl
Which of the following is correct statement regarding the above solutions?
(a) Freezing point will be lowest for solution I.
(b) Freezing point will be highest for solution IV.
(c) Boiling point will be highest for solution IV.
(d) Vapour pressure will be highest for solution II.

7. Identify '*Z*' in the following reaction series,
$$CH_3CH_2CH_2Br \xrightarrow{\text{aq. NaOH}} (X) \xrightarrow[\text{Heat}]{Al_2O_3} (Y) \xrightarrow{Cl_2/H_2O} (Z)$$
(a) Mixture of $CH_3-CH(Cl)-CH_2(Cl)$ and $CH_3-CH(OH)-CH_2(OH)$
(b) $CH_3-CH(OH)-CH_2(Cl)$
(c) $CH_3-CH(Cl)-CH_2(OH)$
(d) $CH_3-CH(Cl)-CH_2(Cl)$

8. When a few typical solutes (such as protein particles, blood corpuscles) are separated by a particular selective membrane then this process is called
(a) transpiration (b) endosmosis
(c) dialysis (d) precipitation.

9. In the electrolytic method of obtaining aluminium from purified bauxite, cryolite is added to alumina in order to
(a) minimise the heat loss due to radiation
(b) protect aluminium produced from oxygen
(c) dissolve bauxite and render it a good conductor of electricity
(d) increase the melting point of bauxite.

10. When α-*D*-glucose and β-*D*-glucose are dissolved in water in two separate beakers I and II respectively and allowed to stand, then
(a) specific rotation in beaker I will decrease while in II will increase upto a constant value
(b) the specific rotation of equilibrium mixture in two beakers will be different
(c) the equilibrium mixture in both beakers will be leavorotatory
(d) the equilibrium mixture in both beakers will contain only cyclic form of glucose.

11. Standard electrode potentials data are useful for understanding the suitability of an oxidant in a redox titration. Some half-cell reactions and their standard potentials are given below :
$$MnO^-_{4(aq.)} + 8H^+_{(aq.)} + 5e^- \longrightarrow Mn^{2+}_{(aq.)} + 4H_2O_{(l)}; \quad E° = 1.51 V$$
$$Cr_2O_7^{2-}{}_{(aq.)} + 14H^+_{(aq.)} + 6e^- \longrightarrow 2Cr^{3+}_{(aq.)} + 7H_2O_{(l)}; \quad E° = 1.38 V$$
$$Fe^{3+}_{(aq.)} + e^- \longrightarrow Fe^{2+}_{(aq.)}; \quad E° = 0.77 V$$
$$Cl_{2(g)} + 2e^- \longrightarrow 2Cl^-_{(aq.)}; \quad E° = 1.40 V$$
Identify the only incorrect statement regarding the quantitative estimation of aqueous $Fe(NO_3)_2$.
(a) MnO_4^- can be used in aqueous HCl.
(b) $Cr_2O_7^{2-}$ can be used in aqueous HCl.
(c) MnO_4^- can be used in aqueous H_2SO_4.
(d) $Cr_2O_7^{2-}$ can be used in aqueous H_2SO_4.

12. A coordination compound of cobalt has molecular formula containing five ammonia molecules, one nitro group and two chlorine atoms for one cobalt atom. One mole of this compound produces three moles ions in an aqueous solution. On reacting this solution, with excess of $AgNO_3$ solution two moles of AgCl get precipitated. The ionic formula of this complex would be
(a) $[Co(NH_3)_4NO_2Cl](NH_3)Cl$
(b) $[Co(NH_3)_5Cl]Cl(NO_2)$
(c) $[Co(NH_3)_5(NO_2)]Cl_2$
(d) $[Co(NH_3)_5](NO_2)Cl_2$

13. If the unit cell of a mineral has cubic packed (*ccp*) array of oxygen atoms with *m* fraction of octahedral holes occupied by aluminium ions and *n* fraction of tetrahedral holes occupied by magnesium ions then *m* and *n* respectively, are
(a) $\frac{1}{2}, \frac{1}{8}$ (b) $1, \frac{1}{4}$ (c) $\frac{1}{2}, \frac{1}{2}$ (d) $\frac{1}{4}, \frac{1}{8}$

14. In the extraction of silver from argentite ore, the ore is treated with dilute solution of NaCN in water in the presence of *Y*,

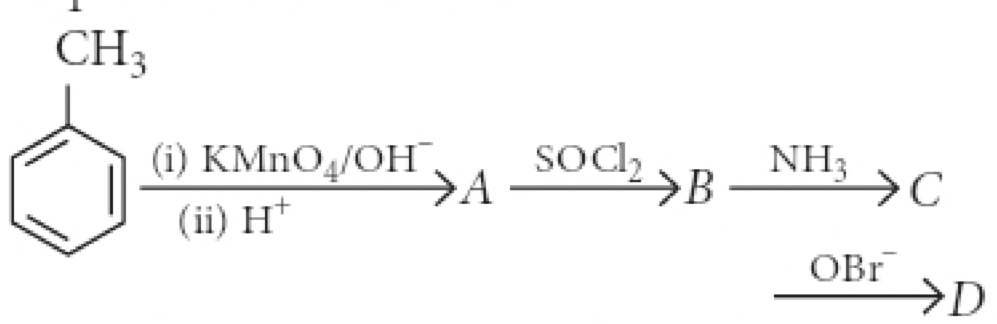
$Ag_2X + 4NaCN + 2Y_2 \longrightarrow 2Na[Ag(CN)_2] + Na_2XY_4$

X and Y in this reaction are represented by

(a) Cl and S (b) S and O

(c) O and O_2 (d) O and Cl.

15. The final product obtained in the following sequence of reactions is



(a) $p\text{-}CH_3C_6H_4NO_2$ (b) $C_6H_5CONH_2$

(c) $C_6H_5NO_2$ (d) $C_6H_5NH_2$

SOLUTIONS

1. (c) : $C_2H_5CHOHCH_3 \xrightarrow{PBr_3}$

$$C_2H_5\text{—}\underset{}{\overset{Br}{CH}}\text{—}CH_3 \xrightarrow[\text{(ii) } D_2O]{\text{(i) Mg, diethyl ether}} C_2H_5\text{—}\overset{D}{CH}\text{—}CH_3$$

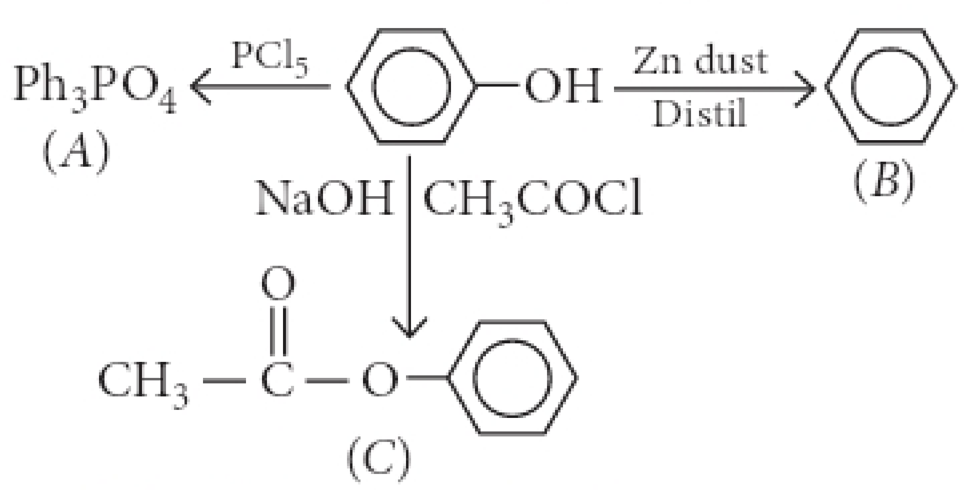
2. (d) : $r = k[A]^{1/2}$

It is a fractional order reaction, as the order is a non-integer, this indicates a chemical chain reaction or complex reaction.

3. (d) : $2KI + Cl_2 \xrightarrow{CHCl_3} \underset{\text{violet}}{I_2} + 2KCl$

$I_2 + 5Cl_2 \text{ (Excess)} + 6H_2O \longrightarrow \underset{\text{colourless}}{2HIO_3} + 10HCl$

4. (b) :



5. (c) **6.** (b) **7.** (b)

8. (c) : Dialysis is the process of separating the particles of colloids from the particles of crystalloids by means of diffusion through a selective membrane placed in water.

9. (c)

10. (a) : α-*D*-glucose and β-*D*-glucose when dissolved in water and allowed to stand, following equilibrium is established.

$$\underset{(+111^\circ)}{\alpha\text{-}D\text{-glucose}} \rightleftharpoons \text{Open chain form} \rightleftharpoons \underset{(+19^\circ)}{\beta\text{-}D\text{-glucose}}$$

Specific rotation of α-form falls, while that of β-form increases until a constant value of +52.5° is reached at equilibrium. This phenomenon is known as mutarotation.

11. (a) : MnO_4^- cannot be used in quantitative estimation of $Fe(NO_3)_2$ in presence of HCl because MnO_4^- will also oxidise Cl^- to Cl_2.

12. (c) : Since the complex with $AgNO_3$ solution gives two moles of AgCl it must have two ionisable Cl-atoms. Hence, the complex is $[Co(NH_3)_5NO_2]Cl_2$. On ionisation, it will give three moles of ions *viz* $[Co(NH_3)_5NO_2]^{2+} + 2Cl^-$.

13. (a) : In *ccp*, O^{2-} ions are 4.

Hence, total negative charge = –8

Fraction of octahedral holes occupied by Al^{3+} ions be m and fraction of tetrahedral holes occupied by Mg^{2+} ions be n.

Total positive charge = $3m + 2n$

By charge balance $3m + 2n = 8$

This relation is satisfied only when $m = 2$ and $n = 1$.

Hence, number of $Al^{3+} = 2$ and number of $Mg^{2+} = 1$

m = Fraction of octahedral voids occupied by Al^{3+}

$= \frac{2}{4} = \frac{1}{2}$ ($\because$ no. of octahedral voids = 4)

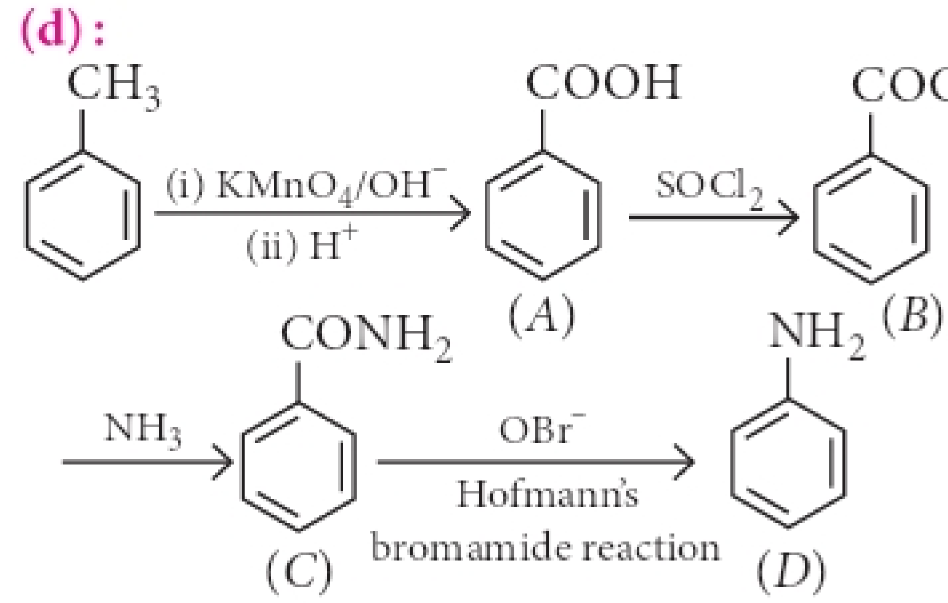
and n = Fraction of tetrahedral voids occupied by Mg^{2+}

$= \frac{1}{8}$ ($\because$ no. of tetrahedral voids = 8)

14. (b) : $Ag_2S + 4NaCN + 2O_2 \longrightarrow 2Na[Ag(CN)_2] + Na_2SO_4$

This process of extraction of Ag is called cyanide process.

15. (d) :



UNSCRAMBLED WORDS

FEBRUARY 2020

1-g- PEWTER	2-a- PRASEODYMIUM
3-e-SINTERING	4-h- VERDIGRIS
5-f- DECOCTIONS	6-c- ADAMANTANE
7-b- ENKEPHALINS	8-d- FERROELECTRICS

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CLASS-XII

BRUSH UP for NEET/JEE 2020

Brush up your concepts to get high rank in NEET/JEE (Main and Advanced) by reading this column. This specially designed column is updated year after year by a panel of highly qualified teaching experts well-tuned to the requirements of these Entrance Tests.

Unit 9 Principles Related to Practical Chemistry

PRACTICAL INORGANIC CHEMISTRY

Identification and Separation of Acidic Radicals

- **Group I :** Salt + dil. H_2SO_4 or dil. HCl.
  - **Carbonate (CO_3^{2-}) :**

    $\underset{\text{Salt}}{Na_2CO_3} + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + \underset{\text{(Effervescence)}}{CO_2\uparrow}$

    $\underset{\text{Lime water}}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\text{White ppt. (milky)}}{CaCO_3} + H_2O$

    $\underset{\text{White ppt.}}{CaCO_3} + H_2O + CO_2 \longrightarrow \underset{\text{Soluble}}{Ca(HCO_3)_2}$
  - Nitrite (NO_2^-) :

    $\underset{\text{Salt}}{2NaNO_2} + H_2SO_4 \longrightarrow Na_2SO_4 + \underset{\text{Nitrous acid}}{2HNO_2}$

    $3HNO_2 \longrightarrow H_2O + 2NO + HNO_3$

    $2NO + O_2 \longrightarrow \underset{\text{(Brown coloured gas)}}{2NO_2\uparrow}$
  - **Sulphite (SO_3^{2-}) :**

    $\underset{\text{Salt}}{Na_2SO_3} + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + SO_2\uparrow$

    $K_2Cr_2O_7 + 3SO_2 + H_2SO_4 \rightarrow K_2SO_4 + \underset{\text{(Green)}}{Cr_2(SO_4)_3} + H_2O$

    $\underset{\text{Salt}}{Na_2SO_3} + BaCl_2 \longrightarrow \underset{\text{White ppt.}}{BaSO_3\downarrow} + 2NaCl$

    $\underset{\text{White ppt.}}{BaSO_3} + 2HCl \longrightarrow \underset{\text{Soluble}}{BaCl_2} + H_2O + SO_2\uparrow$
  - **Sulphide (S^{2-}) :**

    $\underset{\text{Salt}}{Na_2S} + H_2SO_4 \longrightarrow Na_2SO_4 + H_2S\uparrow$

    $\underset{\text{Salt}}{Pb(CH_3COO)_2} + H_2S \rightarrow \underset{\text{Black ppt.}}{PbS\downarrow} + 2CH_3COOH$

    Soluble sulphide reacts with sodium nitroprusside to produce pink violet colour.

    $Na_2S + \underset{\text{Sodium nitroprusside}}{Na_2[Fe(CN)_5NO]} \rightarrow \underset{\text{Pink violet colour}}{Na_4[Fe(CN)_5NOS]}$
  - **Acetate (CH_3COO^-) :**

    $\underset{\text{Salt}}{2CH_3COONa} + H_2SO_4 \longrightarrow \underset{\text{Vinegar smell}}{2CH_3COOH} + Na_2SO_4$

    $\underset{\text{Salt}}{3CH_3COONa} + FeCl_3 \longrightarrow \underset{\text{Blood red colour}}{(CH_3COO)_3Fe} + 3NaCl$
- **Group II :** Salt + conc. H_2SO_4 or conc. HCl and heat.
  - **Chloride (Cl^-) :**

    $\underset{\text{Salt}}{2NaCl} + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$

    $NH_4OH + HCl \rightarrow \underset{\text{White fumes}}{NH_4Cl} + H_2O$

    $HCl + AgNO_3 \rightarrow \underset{\text{White ppt.}}{AgCl\downarrow} + HNO_3$
  - **Chromyl chloride test :** On heating chloride with $K_2Cr_2O_7$ and conc. H_2SO_4 a reddish chromyl chloride (CrO_2Cl_2) gas is produced which gives yellow solution with NaOH due

to sodium chromate and on adding acetic acid, lead acetate solution produces a yellow precipitate of $PbCrO_4$.

$$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$$

$$K_2Cr_2O_7 + 2H_2SO_4 \rightarrow 2KHSO_4 + 2CrO_3 + H_2O$$

$$CrO_3 + 2HCl \rightarrow \underset{\text{Chromyl chloride (Red vapours)}}{CrO_2Cl_2\uparrow} + H_2O$$

$$CrO_2Cl_2 + 4NaOH \rightarrow \underset{\text{Yellow colour}}{Na_2CrO_4} + 2NaCl + 2H_2O$$

$$Na_2CrO_4 + (CH_3COO)_2Pb \longrightarrow \underset{\text{Yellow ppt.}}{PbCrO_4\downarrow} + 2CH_3COONa$$

– **Bromide (Br^-) :**

$$\underset{\text{Salt}}{NaBr} + H_2SO_4 \longrightarrow NaHSO_4 + HBr$$

$$2HBr + H_2SO_4 \longrightarrow \underset{\text{Brown}}{Br_2} + 2H_2O + SO_2$$

Reddish brown bromine gas which turns starch iodide paper blue due to the liberation of iodine from starch iodide.

$$AgNO_3 + HBr \rightarrow \underset{\text{Pale yellow ppt.}}{AgBr\downarrow} + HNO_3$$

$$AgBr + NH_4OH \rightarrow \underset{\text{Soluble silver ammonium bromide complex}}{[Ag(NH_3)_2]Br} + 2H_2O$$

– **Iodide (I^-) :**

$$\underset{\text{Salt}}{2KI} + 2H_2SO_4 \rightarrow 2KHSO_4 + 2HI$$

$$2HI + H_2SO_4 \rightarrow \underset{\text{Violet vapours}}{I_2\uparrow} + SO_2 + 2H_2O$$

On adding $AgNO_3$ solution, a yellow ppt. of AgI is formed which is insoluble in NH_4OH.

$$AgNO_3 + HI \rightarrow \underset{\text{Yellow ppt.}}{AgI\downarrow} + HNO_3$$

– **Nitrate (NO_3^-) :** Light brown fumes of nitrogen dioxide are evolved on heating nitrates with conc. H_2SO_4 which intensify on adding Cu turnings.

$$NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$$

$$4HNO_3 \rightarrow 2H_2O + \underset{\text{Light brown fumes}}{4NO_2\uparrow} + O_2$$

$$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + \underset{\text{Dark brown fumes}}{2NO_2} + 2H_2O$$

– **Oxalate ($C_2O_4^{2-}$) :**

$$\underset{\text{Salt}}{Na_2C_2O_4} + H_2SO_4 \rightarrow Na_2SO_4 + H_2C_2O_4$$

$$H_2C_2O_4 + [H_2SO_4] \rightarrow \underset{\text{Burns with blue flame}}{CO} + \underset{\text{turns lime water milky}}{CO_2} + H_2O + [H_2SO_4]$$

- **Group III :** For detection of this group radicals we need some specific test.

– **Sulphate (SO_4^{2-}) :**

$$\underset{\text{Salt}}{Na_2SO_4} + BaCl_2 \longrightarrow \underset{\text{White ppt. (Insoluble in conc. } HNO_3)}{BaSO_4\downarrow} + 2NaCl$$

– **Phosphate (PO_4^{3-}) :**

$$\underset{\text{Salt}}{Ca_3(PO_4)_2} + 6HNO_3 \longrightarrow 3Ca(NO_3)_2 + 2H_3PO_4$$

$$H_3PO_4 + \underset{\text{Ammonium molybdate}}{12(NH_4)_2MoO_4} + 21HNO_{3(Conc.)} \longrightarrow$$

$$\underset{\text{Canary yellow ppt.}}{(NH_4)_3PO_4\cdot 12MoO_3\downarrow} + 21NH_4NO_3 + 12H_2O$$

– **Borate (BO_3^{3-}) :**

$$\underset{\text{Salt}}{2Na_3BO_3} + 3H_2SO_4 \longrightarrow 3Na_2SO_4 + 2H_3BO_3$$

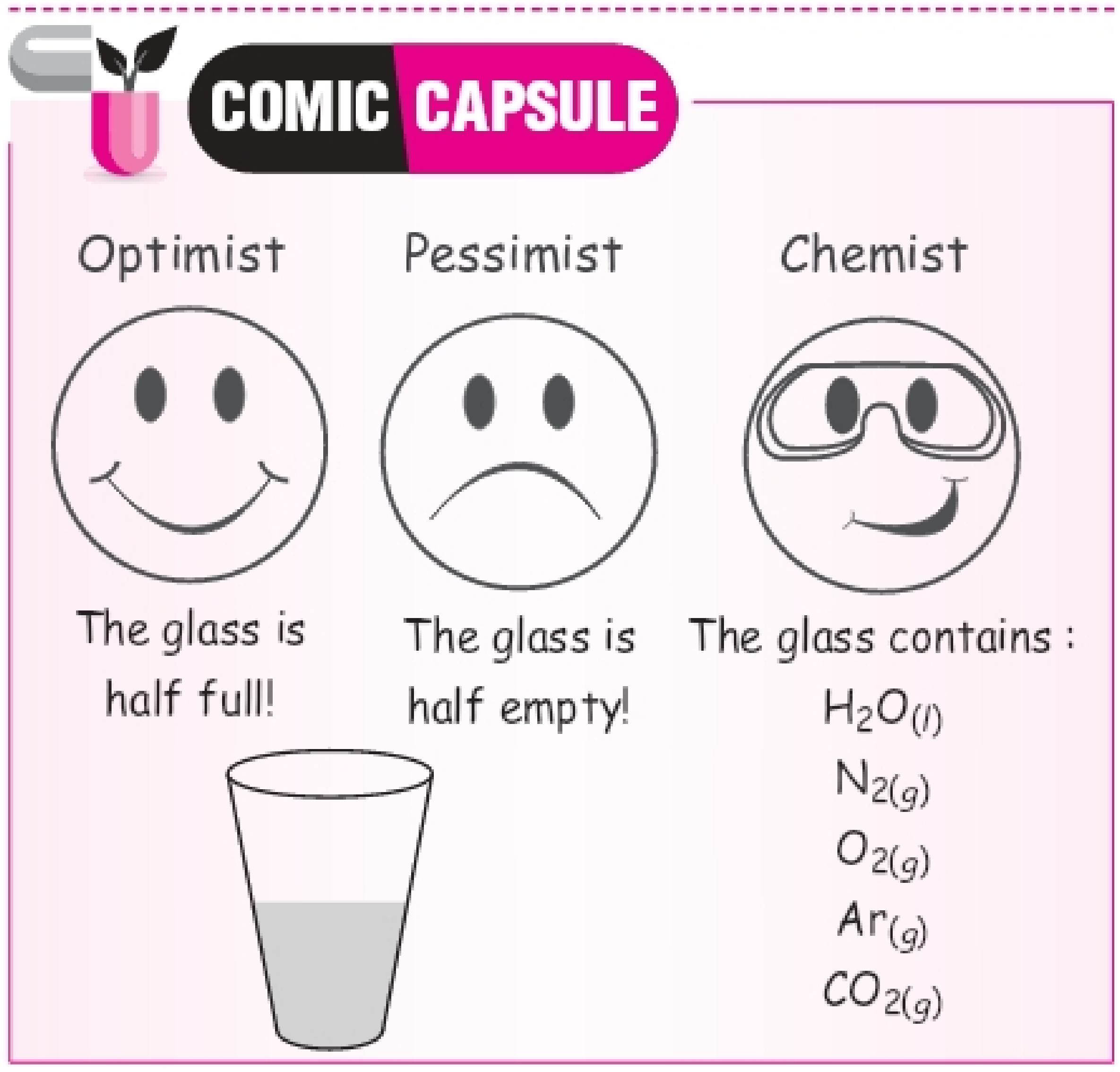
$$H_3BO_3 + 3C_2H_5OH \longrightarrow \underset{\text{Ethyl borate (Burns with green edged flame)}}{(C_2H_5)_3BO_3} + 3H_2O$$

– **Fluoride (F^-) :**

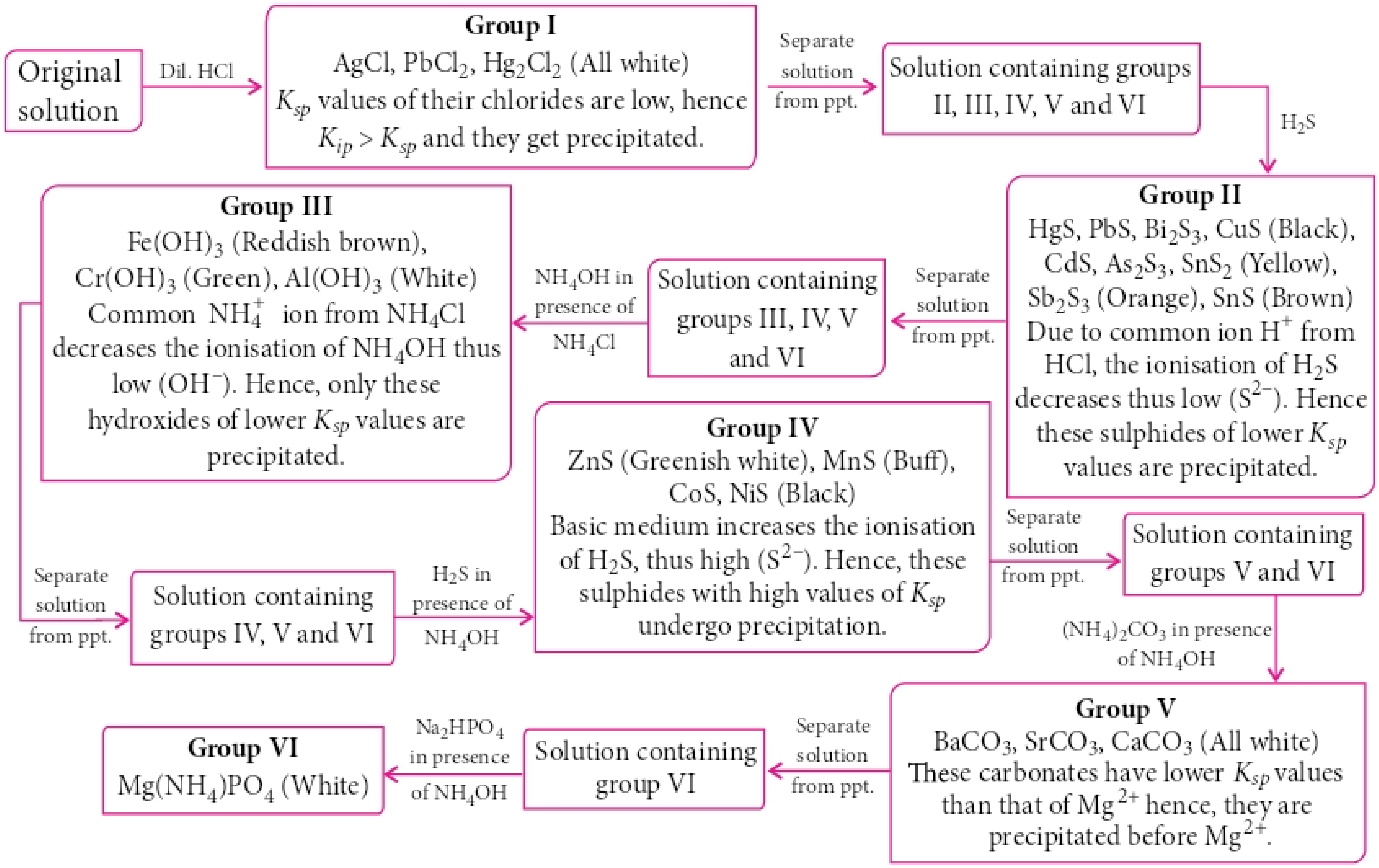
$$\underset{\text{Salt}}{2NaF} + H_2SO_4 \longrightarrow Na_2SO_4 + \underset{\text{Hydrofluoric Acid}}{H_2F_2}$$

$$\underset{\text{Silica}}{SiO_2} + 2H_2F_2 \longrightarrow \underset{\text{Silicon tetrafluoride}}{SiF_4} + 2H_2O$$

$$3SiF_4 + 4H_2O \longrightarrow \underset{\text{Silicic acid (Gelatinous white)}}{H_4SiO_4} + 2H_2SiF_6$$



Identification and Separation of Basic Radicals



Titrimetric Analysis

- Titrimetric or volumetric analysis is a method of finding the volume of one solution which reacts with a definite amount of another solution.
- **Strength of a solution :** It is the amount of solute in grams present per litre of the solution.
  - Strength (g/L) = Normality × Eq. wt.
  - Strength (g/L) = Molarity × Mol. mass
- **Normality equation :** $\underset{\text{(Solution 1)}}{N_1V_1} = \underset{\text{(Solution 2)}}{N_2V_2}$
- **Molarity equation :** $\underset{\text{(Solution 1)}}{M_1V_1n_1} = \underset{\text{(Solution 2)}}{M_2V_2n_2}$

  [$\because$ $N = M \times n$, where n = valency factor]
- **Percentage purity of a given salt**

  $$= \frac{\text{Strength of given sample}}{\text{Strength of pure sample}} \times 100$$

Peep Into Previous Years

1. A solution containing a group-IV cation gives a precipitate on passing H_2S. A solution of this precipitate in dil. HCl produces a white precipitate with NaOH solution and bluish white precipitate with basic potassium ferrocyanide. The cation is

   (a) Co^{2+} (b) Ni^{2+} (c) Zn^{2+} (d) Mn^{2+}

   (JEE Main Online 2017)

2. A white sodium salt dissolves readily in water to give a solution which is neutral to litmus. When silver nitrate solution is added to the aforementioned solution, a white precipitate is obtained which does not dissolve in dil. nitric acid. The anion is

   (a) S^{2-} (b) SO_4^{2-} (c) CO_3^{2-} (d) Cl^-

   (JEE Main 2018)

Practical Organic Chemistry

Detection of the Functional Groups

Alcoholic group (—OH linked to aliphatic carbon chain)

- **Ceric ammonium nitrate test :**

  $$2ROH + [(NH_4)_2Ce(NO_3)_6] \longrightarrow \underset{\text{Pink or red colour}}{[Ce(NO_3)_4R(OH)_2]} + 2NH_4NO_3$$

- **Sodium test :** $2ROH + 2Na \longrightarrow 2RONa + H_2\uparrow$
- **Ester test :**

  $$RCOOH + 2R'OH \xrightarrow{\text{Conc. } H_2SO_4} 2RCOOR' + H_2O$$

- **Xanthate test :** $ROH + KOH \longrightarrow ROK + H_2O$

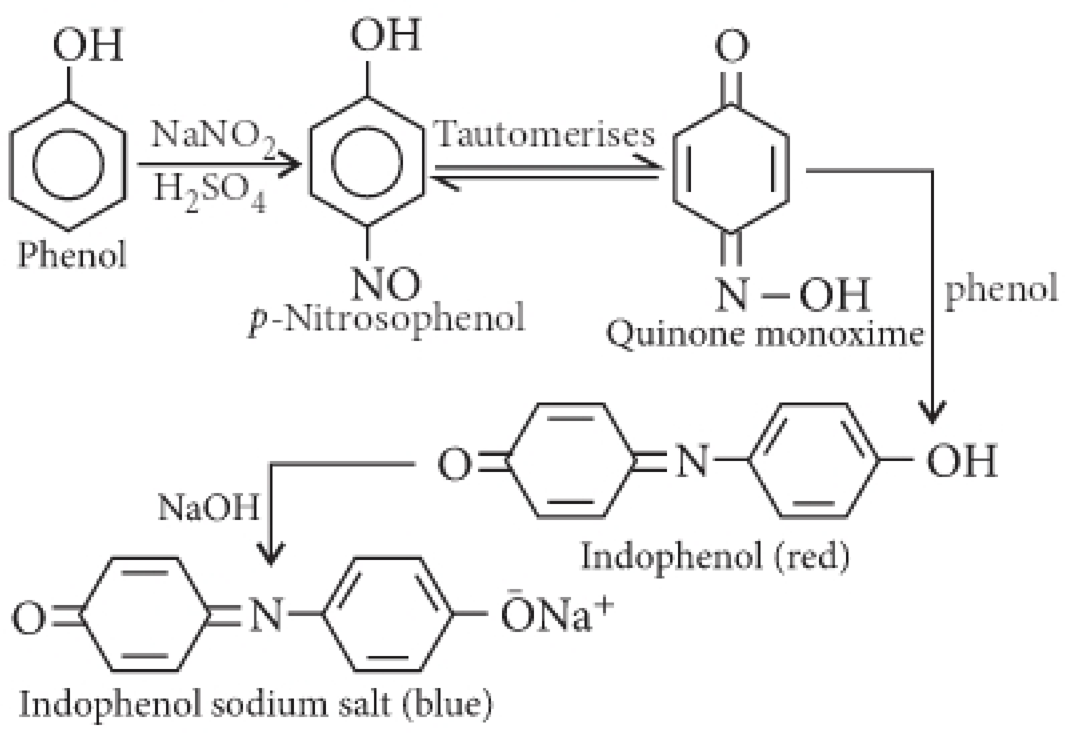
  $$ROK + CS_2 \longrightarrow \underset{\text{Yellow ppt.}}{RO{-}C{\overset{S}{\underset{\bar{S}K^+}{\lessgtr}}}}$$

Phenolic group (–OH linked to benzene ring)

- **$FeCl_3$ test :**

$$\underset{\text{Neutral}}{FeCl_3} + \underset{\text{Phenol}}{6C_6H_5OH} \longrightarrow 3H^+ + \underset{\text{Violet complex}}{[Fe(OC_6H_5)_6]^{3-}} + 3HCl$$

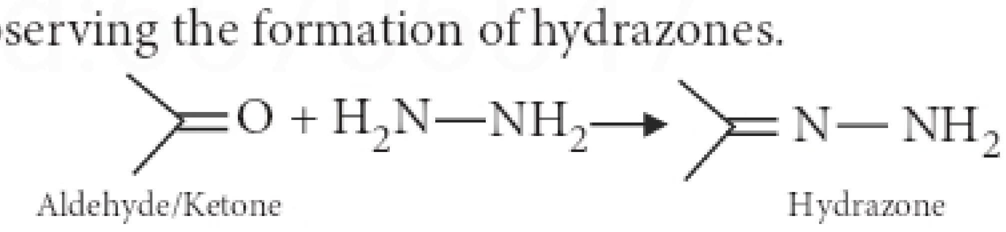
- **Liebermann's nitroso test :**



- **Phthalein test :**
Organic compound + phthalic anhydride + conc. H_2SO_4 $\longrightarrow$ phenolphthalein $\xrightarrow{NaOH}$ pink colour complex

Carbonyl group (>C = O)

The presence of a carbonyl group can be confirmed by treating the organic compound with hydrazine and observing the formation of hydrazones.



- **Tests for aldehyde group :**
  - **Tollen's test :** $\underset{\text{Aldehyde}}{RCHO} + 2[Ag(NH_3)_2]OH \longrightarrow RCOONH_4 + 3NH_3 + H_2O + \underset{\text{Silver mirror}}{2Ag}$
  - **Fehling's test :** $\underset{\text{Aldehyde}}{RCHO} + \underset{\text{Fehling's solution}}{2Cu^{2+} + 5OH^-} \longrightarrow \underset{\text{Red ppt.}}{Cu_2O_{(s)}\downarrow} + RCOO^- + 3H_2O$
  - **Benedict's test :** $RCHO + 2Cu(OH)_2 + NaOH \longrightarrow RCOONa + \underset{\text{Red ppt.}}{Cu_2O\downarrow} + 3H_2O$
  - **Schiff's test :**
  $RCHO + \underset{\text{(Schiff's reagent, colourless)}}{p\text{-Rosaniline hydrochloride}} \longrightarrow$ Pink colour
- **Tests for ketonic group :**
  - **Iodoform test :**
  $RCOCH_3 + 3I_2 + 4NaOH \longrightarrow 3NaI + \underset{\text{Yellow ppt.}}{CHI_3\downarrow} + RCOONa + 3H_2O$
  - **Nitroprusside test :**
  $RCOR$ + Sod.nitroprusside solution + NaOH $\longrightarrow$ Wine red colour complex

Carboxylic group (—COOH)

- **Ester test :**

$$\underset{\text{Carboxylic acid}}{R-COOH} + \underset{\text{Ethyl alcohol}}{CH_3CH_2OH} \xrightarrow[-H_2O]{\text{Conc. }H_2SO_4} \underset{\text{(Ester-fruity smell)}}{\underset{\text{Ethyl carboxylate}}{RCOOCH_2CH_3}}$$

- **Sodium bicarbonate test :**

$$\underset{\text{Carboxylic acid}}{RCOOH} + NaHCO_3 \rightarrow RCOONa + \underset{\text{Effervescence}}{CO_2\uparrow} + H_2O$$

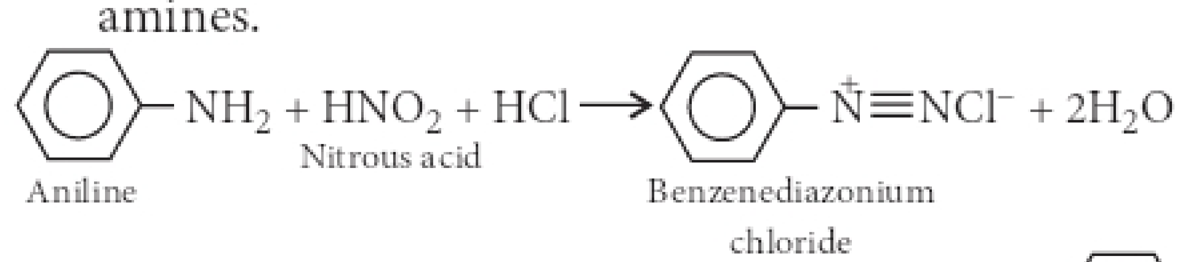
Amino group (—NH_2, Primary)

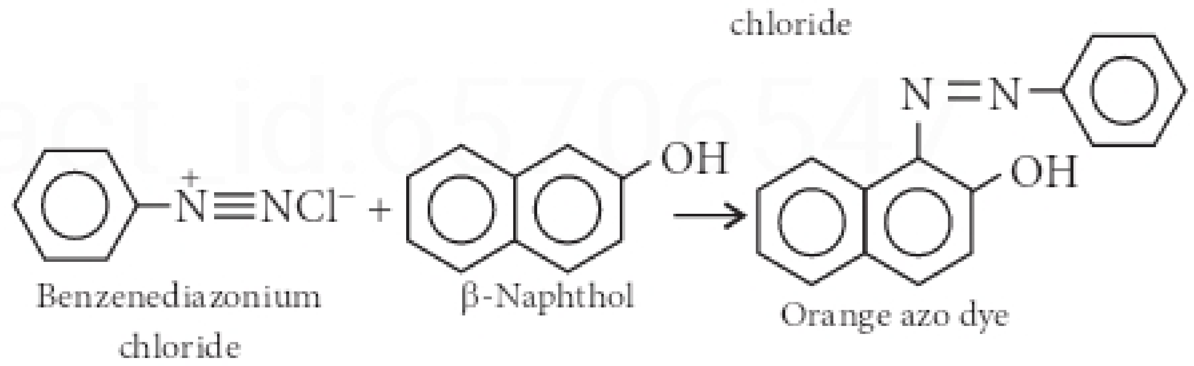
- **Carbylamine test :**

$$RNH_2 + CHCl_3 + 3KOH \xrightarrow{\Delta} \underset{\text{offensive odour}}{\underset{\text{Carbylamine}}{RNC}} + 3KCl + 3H_2O$$

Aromatic or aliphatic 1° amines give this test.

- **Azo-dye test :** This test is given by primary aromatic amines.





Nitro group (–NO_2)

- **Mulliken Barker test :**

$$RNO_2 + 4[H] \xrightarrow{Zn + NH_4Cl} RNHOH + H_2O$$

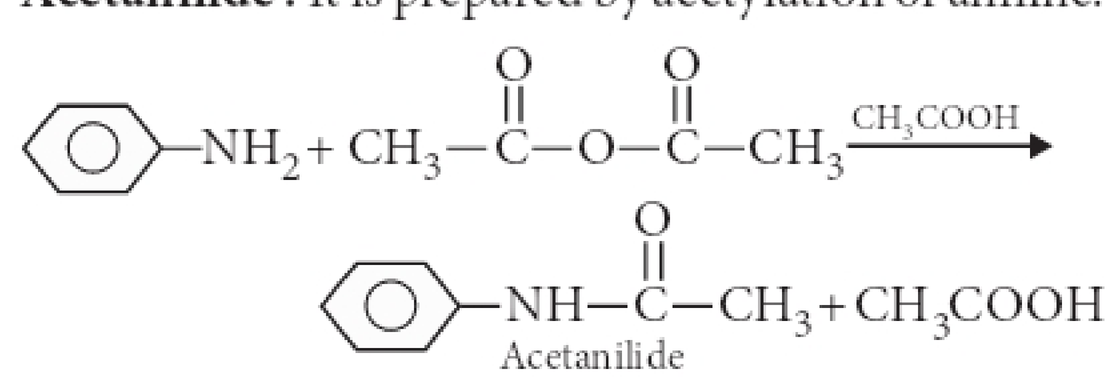
$$RNHOH + 2[Ag(NH_3)_2]OH \longrightarrow RNO + 2H_2O + 4NH_3 + \underset{\text{Grey black ppt.}}{2Ag\downarrow}$$

- **Ferrous hydroxide test :**

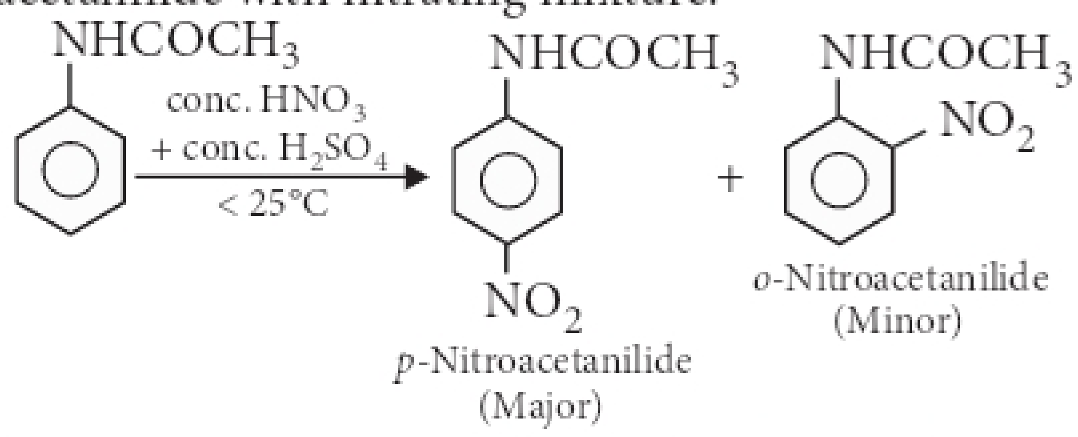
$$RNO_2 + \underset{\text{Light green}}{6Fe(OH)_2} + 4H_2O \longrightarrow RNH_2 + \underset{\text{Brown ppt.}}{6Fe(OH)_3\downarrow}$$

Preparation of Organic Compounds

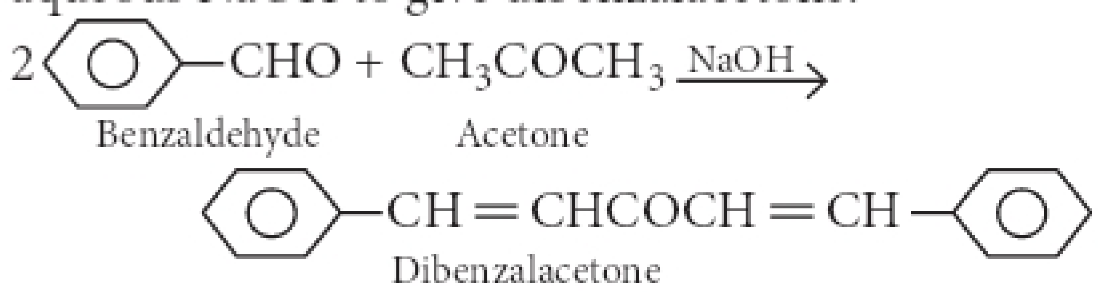
- **Acetanilide :** It is prepared by acetylation of aniline.



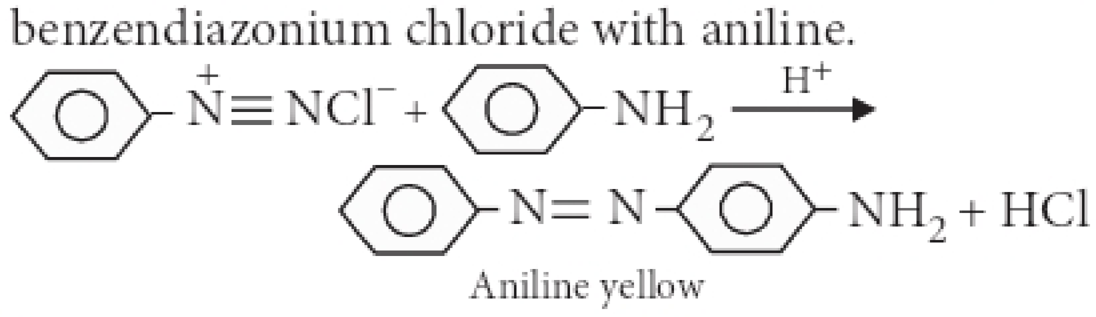
- ***p*-Nitroacetanilide :** It is prepared by nitration of acetanilide with nitrating mixture.



- **Dibenzalacetone :** Benzaldehyde undergoes condensation with acetone in the presence of aqueous NaOH to give dibenzalacetone.

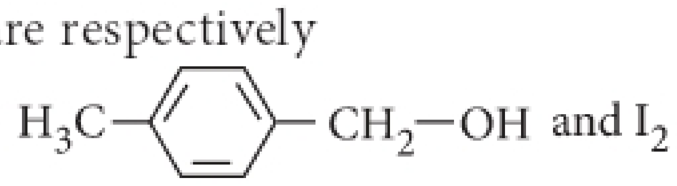


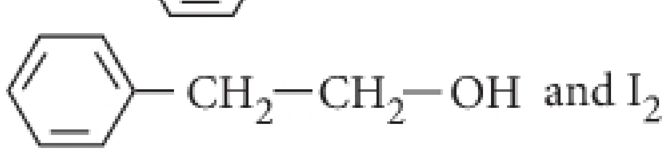
- **Aniline yellow :** It is prepared by reaction of benzendiazonium chloride with aniline.

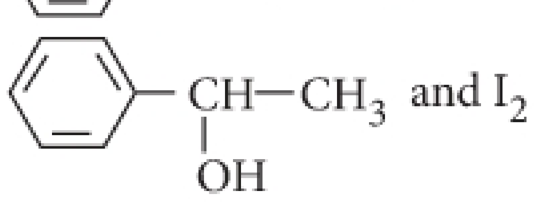


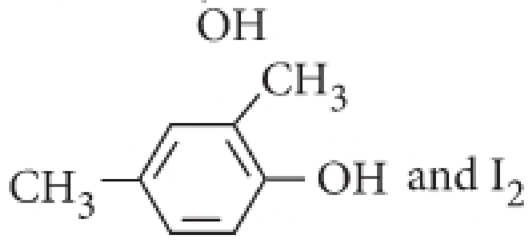
Peep Into Previous Years

3. Compound *A*, $C_8H_{10}O$, is found to react with NaOI (produced by reacting *Y* with NaOH) and yields a yellow precipitate with characteristic smell. *A* and *Y* are respectively

(a) 

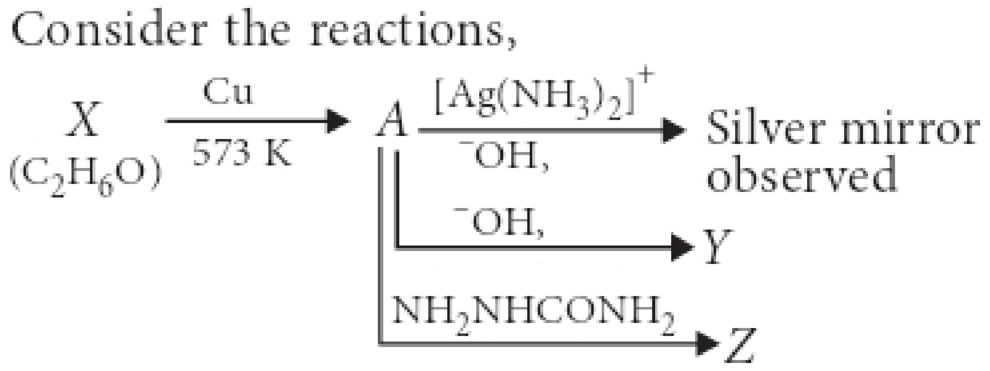
(b) 

(c) 

(d) 

(NEET 2018)

4. Consider the reactions,



Identify *A*, *X*, *Y* and *Z*.

(a) *A*-Methoxymethane, *X*-Ethanol, *Y*-Ethanoic acid, *Z*-Semicarbazide

(b) *A*-Ethanal, *X*-Ethanol, *Y*-But-2-enal, *Z*-Semicarbazone

(c) *A*-Ethanol, *X*-Acetaldehyde, *Y*-Butanone, *Z*-Hydrazone

(d) *A*-Methoxymethane, *X*-Ethanoic acid, *Y*-Acetate ion, *Z*-Hydrazine *(NEET 2017)*

5. The correct statement(s) about the following reaction sequence is(are)

$$\text{Cumene}(C_9H_{12}) \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } O_2} P \xrightarrow[\text{NaOH}]{CHCl_3/} \underset{\text{(Major)}}{Q} + \underset{\text{(Minor)}}{R}$$

$$Q \xrightarrow[PhCH_2Br]{NaOH} S$$

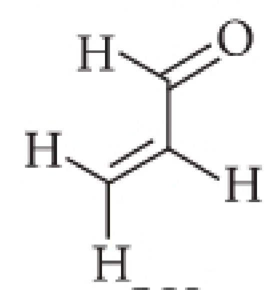
(a) *R* is steam volatile

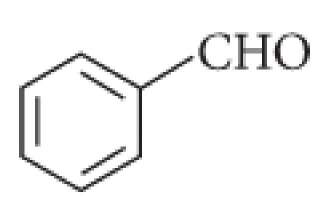
(b) *Q* gives dark violet colouration with 1% aqueous $FeCl_3$ solution

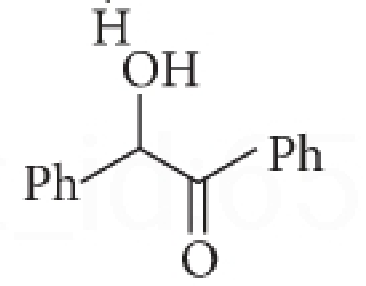
(c) *S* gives yellow precipitate with 2,4-dinitrophenylhydrazine

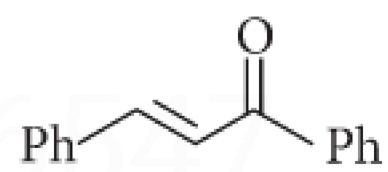
(d) *S* gives dark violet colouration with 1% aqueous $FeCl_3$ solution. *(JEE Advanced 2016)*

6. Positive Tollens' test is observed for

(a) 

(b) 

(c) 

(d) 

(JEE Advanced 2016)

Practical Physical Chemistry

Preparation of Lyophilic and Lyophobic sols

Lyophilic sols are prepared by direct mixing of dispersed phase with dispersion medium, *e.g.*, starch sol is prepared by mixing starch in finely powdered form with boiling water. Colloidal solution of egg albumin is prepared in cold water because in hot water precipitation of egg albumin takes place. Lyophilic sols are quite stable and are not affected by presence of any electrolytic impurity.

Lyophobic sols require special methods of preparation, *e.g.*, ferric hydroxide sol and aluminium hydroxide sol are prepared by hydrolysis of their respective chlorides with boiling water.

$$FeCl_{3(aq.)} + 3H_2O_{(l)} \xrightarrow{\text{Boil}} \underset{\text{Red or Brown sol}}{Fe(OH)_{3(s)}} + 3HCl_{(aq.)}$$

$$AlCl_{3(aq.)} + 3H_2O_{(l)} \rightarrow \underset{\text{Colourless}}{Al(OH)_{3(aq.)}} + 3HCl_{(aq.)}$$

Kinetic Study of Reaction of Iodide Ion with Hydrogen Peroxide at Room Temperature

Hydrogen peroxide oxidises iodide ions to iodine in acidic medium.

$$H_2O_2 + 2I^- + 2H^+ \xrightarrow{\text{slow}} I_2 + 2H_2O$$

The reaction is observed by adding a known volume of sodium thiosulphate solution and starch solution to the reaction mixture. Iodine liberated from KI reacts with sodium thiosulphate solution and is reduced to iodide ions.

$$I_2 + 2S_2O_3^{2-} \xrightarrow{\text{fast}} S_4O_6^{2-} + 2I^-$$

When thiosulphate ions get completely consumed, liberated iodine reacts with starch solution to give blue colour.

$$I_2 + \text{Starch} \longrightarrow \text{Blue complex}$$

The time elapsed before the appearance of blue colour gives an idea about the rate of reaction.

If we prepare a number of reaction mixtures with different concentrations of KI solution, the blue colour appears first in reaction mixture with highest concentration of KI which indicates that rate of reaction is directly proportional to concentration of reactants.

Enthalpy of Neutralisation of Strong acid and Strong base.

Enthalpy of neutralization of strong acid and strong base is measured using simple calorimeter consisting of polythene bottle. Known volumes of standard solution of an acid and alkali are mixed and change in temperature is recorded.

Now enthalpy of neutralization can be calculated as :

$$\text{Heat of neutralization} = \frac{(W + m) \times \Delta t \times 4.2}{N \times V_{(\text{mL})}} \text{ kJ}$$

or $$\text{Heat of neutralization} = \frac{(W + m) \times \Delta t}{N \times V_{(\text{mL})}} \text{ cal}$$

where, W = water equivalent of calorimeter

m = mass of mixture of solution after neutralization

Δt = change in temperature

N = normality of acid or base under investigation

V = volume of acid or base under investigation in mL.

Variation of Cell Potential in Zn|Zn^{2+}||Cu^{2+}|Cu with Change in Concentration of Electrolytes ($CuSO_4$ and $ZnSO_4$) at Room Temperature

- Reduction potential of an electrode increases with increase in concentration of the electrolyte.

  $$M^{n+}_{(aq.)} + ne^- \longrightarrow M_{(s)}$$

- In the zinc-copper electrochemical cell, zinc electrode acts as anode while copper electrode acts as cathode.

  $$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$$

- E°_{cell} increases if E°_{cathode} increases and E°_{anode} decreases. Thus, higher conc. of Cu^{2+} and lower conc. of Zn^{2+} ions increase the E°_{cell} for Zn | Zn^{2+} || Cu^{2+} | Cu.

- The relation between concentration of the eletrolyte and the standard electrode potential, is given in the form of Nernst equation :

  $$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059}{n}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$$

PEEP INTO PREVIOUS YEARS

7. The most appropriate method of making egg-albumin sol is
   (a) break an egg carefully and transfer the transparent part of the content to 100 mL of 5% w/V saline solution and stir well.
   (b) keep the egg in boiling water for 10 minutes. After removing the shell, transfer the yellow part of the content to 100 mL of 5% w/V saline solution and homogenize with a mechanical shaker.
   (c) keep the egg in boiling water for 10 minutes. After removing the shell, transfer the white part of the content to 100 mL of 5% w/V saline solution and homogenize with a mechanical shaker.
   (d) break an egg carefully and transfer only the yellow part of the content to 100 mL of 5% w/V saline solution and stir well.
   (JEE Main Online 2016)

8. Which mixture of the solutions will lead to the formation of negatively charged colloidal $[AgI]I^-$ sol?
   (a) 50 mL of 0.1 M $AgNO_3$ + 50 mL of 0.1 M KI
   (b) 50 mL of 1 M $AgNO_3$ + 50 mL of 1.5 M KI
   (c) 50 mL of 1 M $AgNO_3$ + 50 mL of 2 M KI
   (d) 50 mL of 2 M $AgNO_3$ + 50 mL of 1.5 M KI
   (NEET 2019)

POINTS FOR EXTRA SCORING

- Oxidation of methyl ketones with sodium hypohalite gives carboxylic acids with one carbon atom less than the corresponding ketones-haloform reaction.
- Acidified potassium dichromate solution is used by police to test that a person is drunk or not which has inorganic colour. The person is asked to breathe into the solution taken in a test tube. If the person has consumed alcohol, the orange colour will change into green colour due to oxidation of alcohol and reduction of acidified potassium dichromate to green colour chromium sulphate.
- Tests for Fe^{2+} and Fe^{3+} ions : Ferric salts react with potassium ferrocyanide to give blue ppt. or colourations due to the formation of ferri-ferrocyanide or prussian blue.

CONCEPT MAP

SURE
(SOLUTIONS, ELE

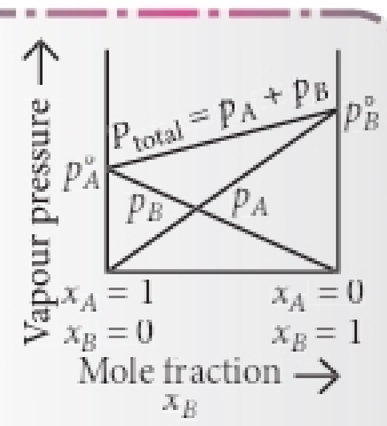
Solutions

- **Henry's law :** $p = K_H x$ (where, K_H is Henry's law constant.)
- **Raoult's law :** For a solution of volatile liquids, the partial vapour pressure of each component of the solution is directly proportional to its mole fraction present in solution. $p_1 = p^\circ_1 x_1$ and $p_2 = p^\circ_2 x_2$; where, p°_1 and p°_2 are vapour pressures of pure components 1 and 2 respectively, at the same temperature.
- **Dalton's law of partial pressure :** $p_{total} = p_1 + p_2 = x_1 p_1^\circ + x_2 p_2^\circ = (1 - x_2)p_1^\circ + x_2 p_2^\circ = p_1^\circ + (p_2^\circ - p_1^\circ)x_2$

- **Ideal Solutions :** $A - B$ interactions ≈ $A - A$ and $B - B$ interactions

$\Delta H_{mix} = 0, \Delta V_{mix} = 0$

e.g., dilute solutions,
benzene + toluene,
n-hexane + *n*-heptane.



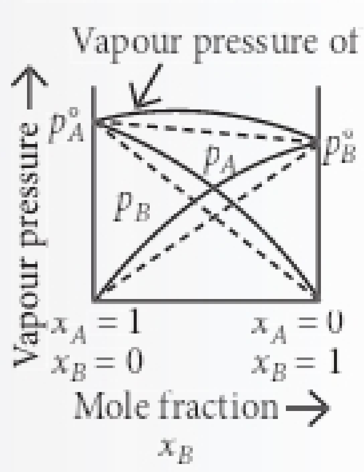
Non-ideal solutions :

- **Positive deviation from Raoult's law :** $A - B$ interactions << $A - A$ and $B - B$ interactions ; $\Delta H_{mix} > 0, \Delta V_{mix} > 0$ (Fig. a).

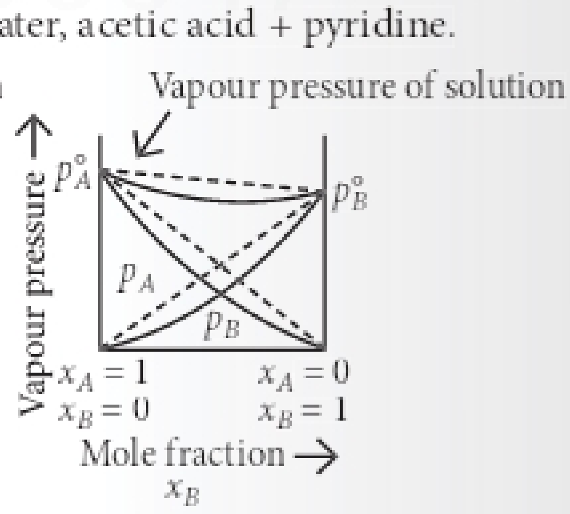
e.g., acetone + ethanol, acetone + CS_2, water + methanol.

- **Negative deviation from Raoult's law :** $A - B$ interactions >> $A - A$ and $B - B$ interactions ; $\Delta H_{mix} < 0, \Delta V_{mix} < 0$ (Fig. b).

e.g., acetone + aniline, HCl + water, acetic acid + pyridine.



(Fig. *a*)



(Fig. *b*)

Colligative Properties

- **Relative Lowering of Vapour Pressure :**

$$\frac{p_1^\circ - p_1}{p_1^\circ} = x_2 = \frac{n_2}{n_1 + n_2} = \frac{n_2}{n_1} = \frac{w_2 \times M_1}{M_2 \times w_1} \quad (\because \text{for dilute solutions, } n_2 << n_1)$$

- **Elevation in boiling point :** $\Delta T_b = T_b - T_b^\circ$

$$\Delta T_b \propto m \text{ or } \Delta T_b = K_b m = K_b \left(\frac{w_2 \times 1000}{M_2 \times w_1(\text{in g})}\right)$$

- **Depression in freezing point :** $\Delta T_f = T_f^\circ - T_f$

$$\Delta T_f \propto m \text{ or } \Delta T_f = K_f m = K_f \left(\frac{w_2 \times 1000}{M_2 \times w_1(\text{in g})}\right)$$

- **Osmotic pressure :** $\pi = CRT = (n_2/V)RT$, $\pi V = w_2 RT/M_2$ or $M_2 = w_2 RT/\pi V$

- **van't Hoff Factor :** It is defined as the ratio of the experimental value of the colligative property to the calculated value of the colligative property.
- If $i > 1$, solute undergoes dissociation in the solution and if $i < 1$, solute undergoes association in the solution.

$\alpha_{dissociation} = i - 1/n - 1$; $\alpha_{association} = (1 - i)n/n-1$

Electrochemistry

Electrochemical Cell			
Type	Energy change	Anode	Cathode
Electrolytic cell	Electrical energy → Chemical energy	+	–
Galvanic (voltaic) cell	Chemical energy → Electrical energy	–	+

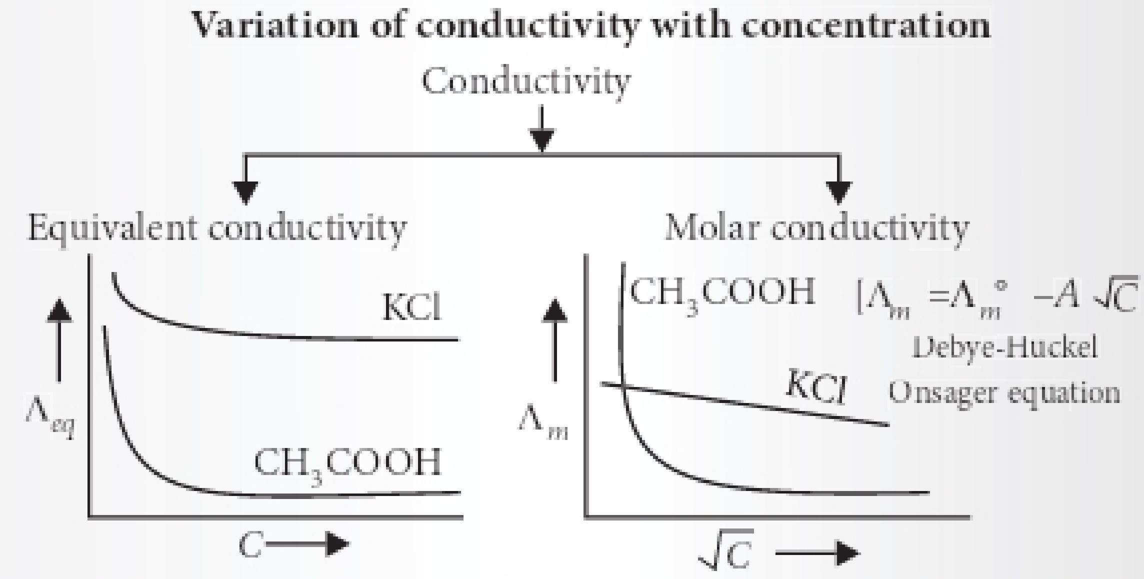
- **EMF of cell :** $E^\circ_{cell} = E^\circ_{right} - E^\circ_{left} = E^\circ_{cathode} - E^\circ_{anode}$
- **Nernst equation :** For a reaction, $M^{n+}_{(aq)} + ne \longrightarrow M_{(s)}$;

$$E_{cell} = E^\circ_{cell} - \frac{2.303RT}{nF}\log\frac{1}{[M^{n+}_{(aq)}]} \; ; \; E_{cell} = E^\circ_{cell} - \frac{0.0591}{n}\log\frac{1}{[M^{n+}_{(aq)}]}$$

- **Relation between cell potential and Gibbs energy change :** $\Delta G^\circ = -nFE^\circ_{cell}$; $\Delta G^\circ = -2.303\,RT\log K_c$

	Specific Conductance	Equivalent Conductance	Molar Conductance
Formula	$\kappa = G\frac{l}{a}$	$\Lambda_{eq} = \kappa \times \frac{1000}{\text{Normality}}$	$\Lambda_m = \kappa \times \frac{1000}{\text{Molarity}}$

Variation of conductivity with concentration



- **Kohlrausch's law :** For an electrolyte, $A_x B_y$: $\Lambda^\circ_m = x\lambda^\circ_+ + y\lambda^\circ_-$ or $\Lambda^\circ_{eq} = \lambda^\circ_+ + \lambda^\circ_-$
- **Degree of dissociation** $(\alpha) = \Lambda^c_m / \Lambda^\circ_m$
- **Faraday's first law of electrolysis :** $w \propto Q$

$$w = ZQ = Z \times I \times t; \; Z = \frac{\text{Eq. wt. of substance}}{96500}$$

- **Faraday's second law of electrolysis :** $w_1/w_2 = E_1/E_2$.

- **Cells and their reactions :**

Cell	Anode Reaction
Dry cell	$Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$
Mercury cell	$Zn_{(s)} + 2OH^-_{(aq)} \rightarrow ZnO_{(s)} + H_2O_{(l)} + 2e^-$
Lead storage cell	$Pb_{(s)} + SO_4^{2-}{}_{(aq)} \rightarrow PbSO_{4(s)} + 2e^-$
Nickel-Cadmium cell	$Cd_{(s)} + 2OH^-_{(aq)} \rightarrow Cd(OH)_{2(s)} + 2e^-$
Fuel cell	$2H_{2(g)} + 4OH^-_{(aq)} \rightarrow 4H_2O_{(l)} + 4e^-$

SHOT TOPICS OF PHYSICAL CHEMISTRY

(ELECTROCHEMISTRY, CHEMICAL KINETICS AND SURFACE CHEMISTRY)

Chemical Kinetics

Rate law, integrated rate law, half-life, units of rate constant and graph for the reactions of different orders :

Order	Rate law	Integrated rate law
0	Rate = $k[A]^0$	$[A]_t = -kt + [A]_0$
1	Rate = $k[A]^1$	$\ln[A]_t = -kt + \ln [A]_0$
2	Rate = $k[A]^2$	$1/[A]_t = kt + 1/[A]_0$
2	Rate = $k[A]\,[B]$	$kt = \frac{1}{[A]_0 - [B]_0} \ln \frac{[B]_0[A]}{[A]_0[B]}$
n	Rate = $k[A]^n$	$(n-1)kt = \frac{1}{[A]^{n-1}} - \frac{1}{[A_0]^{n-1}}$

Order	Half-life	Units of rate constant	Graph
0	$t_{1/2} = [A]_0/2k$	mol L^{-1} s^{-1}	$[A]$ *vs* t; slope = $-k$
1	$t_{1/2} = 0.693/k$	s^{-1}	$\ln[A]$ *vs* t; slope = $-k$
2	$t_{1/2} = 1/k\,[A]_0$	L mol^{-1} s^{-1}	$1/[A]$ *vs* t; slope = k
2	–	L mol^{-1} s^{-1}	$1/[A]$ *vs* t; slope = k
n	$t_{1/2} = \frac{2^{n-1}-1}{k_n(n-1)[A]_0^{n-1}}$	$(\text{mol L}^{-1})^{1-n}\text{s}^{-1}$	$\frac{1}{[A]^{n-1}}$ *vs* t; slope = k

- **Relationships between time periods for different fractions of reaction of first order to complete :**
  $t_{3/4}$ or $t_{75\%} = 2t_{1/2}$, $t_{87.5\%} = 3t_{1/2}$, $t_{93.75\%} = 4t_{1/2}$,
  $t_{96.87\%} = 5t_{1/2}$, $t_{99.9\%} = 10t_{1/2}$

- **Arrhenius equation :** $k = Ae^{-E_a/RT}$

$$\log k = \log A - \frac{E_a}{2.303\,RT}\ ;\ \log\frac{k_2}{k_1} = \frac{E_a}{2.303\,R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

- **Collision theory :** $k = P \cdot Z \cdot e^{-E_a/RT}$ where, P = orientation factor or probability factor. Z = collision frequency.
- **Rate of radioactive disintegration/Decay :** It follows first order kinetics.

  Disintegration constant $(k) = \frac{2.303}{t}\log\frac{N_0}{N}$ or $\frac{2.303}{t}\log\frac{a}{a-x}$

  (N_0 = initial no. of atoms, N = atoms present at time t, a = initial amount, x = amount disintegrated in time t).

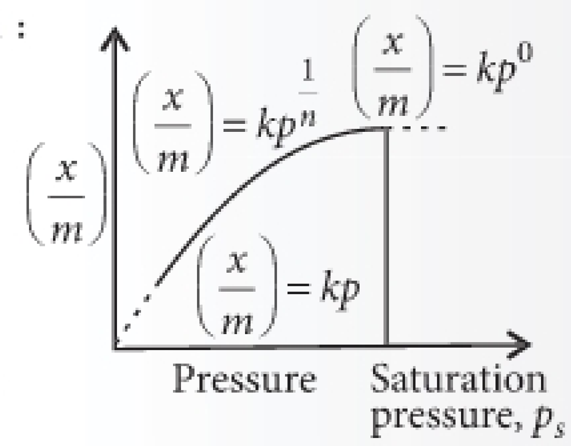
  Half-life $(t_{1/2}) = 0.693/k$ and average life $(\tau) = 1/k = t_{1/2}/0.693$.

	Cathode Reaction
	$MnO_{2(s)} + NH^+_{4(aq)} + e^- \rightarrow MnO(OH)_{(s)} + NH_{3(g)}$
	$HgO_{(s)} + H_2O_{(l)} + 2e^- \rightarrow Hg_{(l)} + 2OH^-_{(aq)}$
	$PbO_{2(s)} + SO_4^{2-}{}_{(aq)} + 4H^+_{(aq)} + 2e^- \rightarrow PbSO_{4(s)} + 2H_2O_{(l)}$
	$NiO_{2(s)} + 2H_2O_{(l)} + 2e^- \rightarrow Ni(OH)_{2(s)} + 2OH^-_{(aq)}$
	$2O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-_{(aq)}$

Surface Chemistry

- **Adsorption :** The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid.
- **Physisorption :** Molecules are held by weak van der Waals' forces. Low heat of adsorption and non-specific. Decreases with increase in temperature. Forms multimolecular layer and is reversible.
- **Chemisorption :** Molecules are held by strong chemical bonds. High heat of adsorption and specific. Increases with increase in temperature. Forms unimolecular layer and is irreversible.
- **Positive adsorption :** Concentration of the adsorbate is more on the surface of the adsorbent than in the bulk.
- **Negative adsorption :** Concentration of the adsorbate increases in the bulk after adsorption.
- **Freundlich adsorption isotherm :**
  For low pressure, $x/m \propto p$
  For high pressure, $x/m \propto p^0$
  For intermediate pressures,
  $x/m \propto p^{1/n} (n > 1)$

  $\log\frac{x}{m} = \log k + \frac{1}{n}\log p$



- **Langmuir adsorption isotherm :**
  $\frac{x}{m} = \frac{K'P}{1+KP}$

- **Catalysis :** The phenomenon of enhancing the rate of a chemical reaction by using a catalyst.
- **Selectivity :** Ability of a catalyst to direct the reaction to yield a particular product.
- **Activity :** Capacity to increase the speed of the chemical reaction.

- **Colloids :** A heterogeneous system in which particle size is between 1 and 1000 nm.

Based on physical state of dispersed phase and dispersion medium :

- **Sols :** Solids in liquids *e.g.*, paints • **Gels :** Liquids in solids *e.g.*, cheese
- **Emulsions :** Liquids in liquids.
  – Oil in water type emulsions *e.g.*, milk.
  – Water in oil type emulsions *e.g.*, butter.

Based on nature of interaction between dispersed phase and dispersion medium :

- **Lyophilic colloids :** Liquid-loving, directly formed, reversible in nature, quite stable, cannot be easily coagulated.
- **Lyophobic colloids :** Liquid-hating, prepared by special methods, readily coagulated, irreversible, not stable, and need stabilising agents for their preservation.

Based on type of particles of the dispersed phase :

- **Multimolecular colloids :** Formed by aggregation of a large number of atoms or molecules (diameter < 1 nm) held by weak van der Waals' forces.
- **Macromolecular colloids :** Formed by molecules of large size.
- **Associated colloids :** Formed by substances which at low concentrations behave as normal strong electrolytes, but at higher concentrations exhibit colloidal behaviour due to the formation of aggregates (called micelles).

Answer Key For Peep Into Previous Years

1.	(c)	2.	(d)	3.	(c)	4.	(b)	5.	(b, c)	6.	(a, b,c)
7.	(a)	8.	(b)								

WRAP it up!

1. For the identification of β-naphthol using dye test, it is necessary to use
   (a) dichloromethane solution of β-naphthol
   (b) acidic solution of β-naphthol
   (c) neutral solution of β-naphthol
   (d) alkaline solution of β-naphthol.

2. Sodium nitroprusside when added to an alkaline solution of sulphide ions produces a colouration which is
   (a) red (b) blue (c) brown (d) purple.

3. Phenol can be distinguished from ethyl alcohol by all reagents except
   (a) NaOH (b) $FeCl_3$ (c) Br_2/H_2O (d) Na

4. The basic principle of Cottrell's precipitator is
   (a) neutralisation of charge on colloidal particles
   (b) scattering of light
   (c) Le-Chatelier's principle
   (d) peptization.

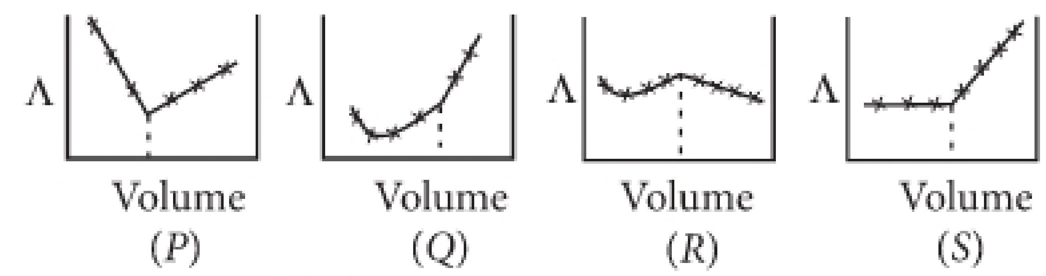
5. A substance on treatment with dil. H_2SO_4 liberates a colourless gas which produces
   I. turbidity with baryta water and
   II. turns acidified dichromate solution green.
   The reaction involved indicate the presence of
   (a) CO_3^{2-} (b) S^{2-} (c) SO_3^{2-} (d) NO_3^-.

6. Mercurous ion is represented as
   (a) Hg_2^{2+} (b) Hg^{2+}
   (c) $Hg + Hg^{2+}$ (d) $3Hg^{3+}$

7. Silver obtained from argentiferrous lead containing lead impurity is purified by
   (a) distillation (b) froth floatation
   (c) cupellation (d) treatment of KCN.

8. The reddish-brown coloured gas formed when nitric oxide is oxidised by air is
   (a) N_2O_5 (b) N_2O_4 (c) NO_2 (d) N_2O_3

9. Gradually $AgNO_3$ is added to an aqueous KCl solution and the conductivity of the solution was measured. Which of the following plots of conductance (Λ) versus volume of $AgNO_3$ is correct?



   (a) P (b) Q (c) R (d) S

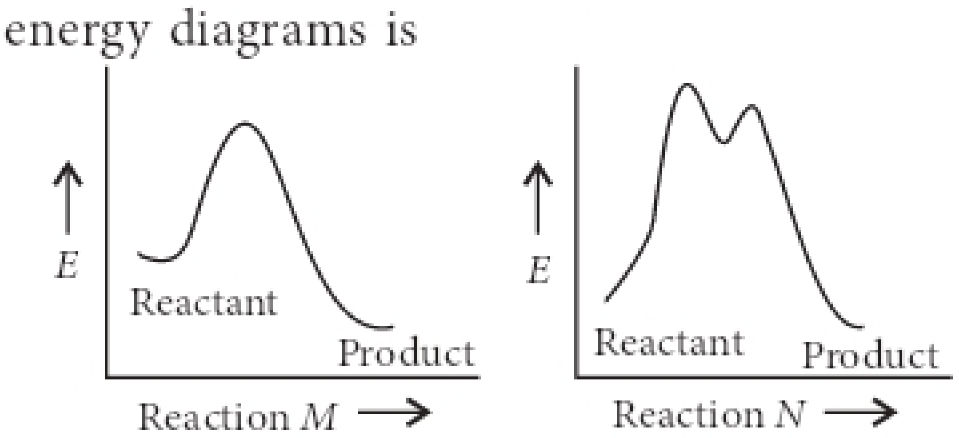
10. An organic compound is treated with $NaNO_2$ and dil. HCl at 0°C. The resulting solution is added to an alkaline solution of β-naphthol, a brilliant red dye is produced. It shows that organic compound must contain
    (a) $-NO_2$ group (b) aromatic $-NH_2$ group
    (c) $-CONH_2$ group (d) aliphatic $-NH_2$ group.

11. When H_2S gas is passed into a mixture of Mn^{2+}, Ni^{2+}, Cu^{2+} and Hg^{2+} ions in an acidified aqueous solution, then precipitates formed will be
    (a) CuS and HgS (b) MnS and CuS
    (c) MnS and NiS (d) NiS and HgS.

12. Which of the following is soluble in yellow ammonium sulphide?
    (a) CuS (b) CdS (c) SnS (d) PbS

13. Acetaldehyde and benzaldehyde can be differentiated by
    (a) Fehling test (b) Iodoform test
    (c) Tollens' reagent (d) both (a) and (b).

14. The correct statement regarding the following energy diagrams is



    (a) reaction M is faster and less exothermic than reaction N
    (b) reaction M is slower and less exothermic than reaction N

(c) reaction M is faster and more exothermic than reaction N

(d) reaction M is slower and more exothermic than reaction N.

15. When excess of dilute NH_4OH is added to an aqueous solution of copper sulphate, an intense blue colour is obtained. This is due to the presence of

(a) $CuSO_4$ (b) $Cu(OH)_2$
(c) $[Cu(NH_3)_4]^{2+}$ (d) $(NH_4)_2SO_4$

16. $CH_3CH_2CH(OH)CH_3$ and $CH_3(CH_2)_2CH_2OH$ can be best distinguished by

(a) Lucas test (b) iodoform test
(c) Victor-Meyer's test (d) all of these.

17. When neutral solution of $FeCl_3$ is added to acetate ion solution then which colour solution is formed?

(a) Blue (b) Green
(c) Blood red (d) Colourless

18. On addition of 1 mL solution of 10% NaCl to 10 mL gold solution in the presence of 0.025 g of starch, the coagulation is prevented because starch has the gold number equal to

(a) 25 (b) 0.025 (c) 0.25 (d) 2.5

19. Aniline and cyclohexylamine can be differentiable by

(a) Hinsberg test (b) *iso*-cyanide test
(c) $NaNO_2$, HCl then β-naphthol
(d) NaOH.

20. A gas X is passed through the water to form a saturated solution. The aqueous solution on treatment with silver nitrate to gives a white precipitate. The saturated aqueous solution also dissolves magnesium ribbon with evolution of colourless gas Y. Identify X and Y.

(a) $X = CO_2, Y = Cl_2$ (b) $X = Cl_2, Y = CO_2$
(c) $X = Cl_2, Y = H_2$ (d) $X = H_2, Y = Cl_2$

SOLUTIONS

1. (d)

2. (d): $Na_2S + \underset{\text{Sodium nitroprusside}}{Na_2[Fe(CN)_5(NO)]} \longrightarrow \underset{\text{Sodium thionitroprusside}}{Na_4[Fe(CN)_5(NOS)]}$

3. (d) **4.** (a)

5. (c): $Na_2SO_3 + H_2SO_4(\text{dil.}) \longrightarrow Na_2SO_4 + H_2O + SO_2\uparrow$

$\underset{\text{(Baryta water)}}{Ba(OH)_2} + SO_2 \longrightarrow \underset{\text{(Turbidity)}}{BaSO_3} + H_2O$

$K_2Cr_2O_7 + H_2SO_4 + 3SO_2 \longrightarrow K_2SO_4 + \underset{\text{Green}}{Cr_2(SO_4)_3} + H_2O$

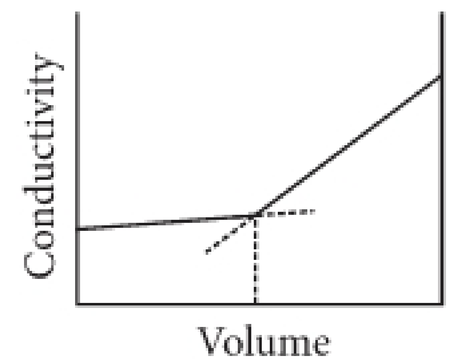
6. (a) **7.** (c)

8. (c): $2NO + O_2 \longrightarrow 2NO_2$

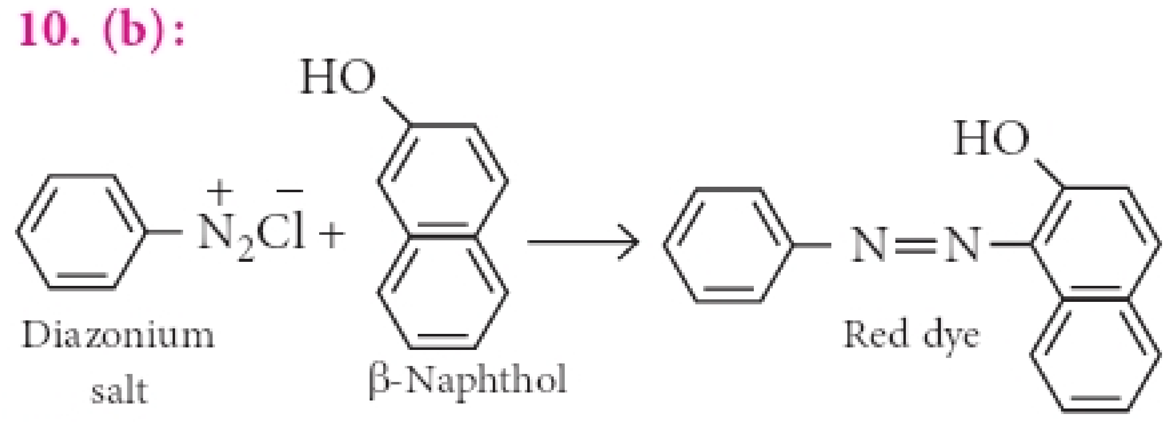
9. (d): $AgNO_3 + KCl \longrightarrow AgCl + KNO_3$

i.e., $Ag^+ + K^+ + Cl^- + NO_3^- \longrightarrow KNO_3 + AgCl$

In the early stages of this titration, with the addition of silver nitrate, the conductance does not change very much because the Cl^- ions are replaced by NO_3^- ions and both have almost same ionic conductances. After the end point is reached, the excess of the added (*i.e.*, addition of volume of reagent) salt causes a sharp increase in conductance.



10. (b):

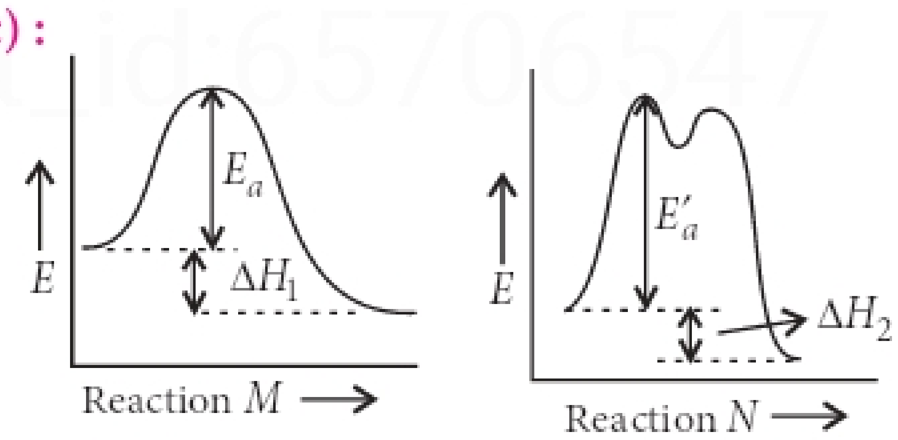


11. (a)

12. (c): $SnS + (NH_4)_2S_2 \longrightarrow \underset{\text{(Soluble)}}{(NH_4)_2SnS_3}$

13. (d)

14. (c):



$E_a < E'_a$; so, reaction M is faster.

$\Delta H_1 > \Delta H_2$; so, reaction M is more exothermic.

15. (c): $CuSO_4 + 4NH_4OH \longrightarrow \underset{\text{Intense blue colour}}{[Cu(NH_3)_4]^{2+}}$

16. (d)

17. (c): $3CH_3COONa + FeCl_3 \longrightarrow \underset{\substack{\text{Ferric acetate} \\ \text{(Blood red colour)}}}{Fe(CH_3COO)_3} + 3NaCl$

18. (a) **19.** (c)

20. (c): Because a saturated solution of (X) gives white ppt. with $AgNO_3$ solution, so X may be Cl_2.

$\underset{X}{Cl_2} + H_2O \longrightarrow HCl + HClO$

$HCl + AgNO_3 \longrightarrow \underset{\text{(White ppt.)}}{AgCl\downarrow} + HNO_3$

$2HCl + Mg \longrightarrow MgCl_2 + \underset{Y}{H_2\uparrow}$

∴ X is Cl_2 and Y is H_2.



CBSE warm-up!

Exam on 7^{th} March 2020

CLASS-XII

Practice questions for CBSE Exams as per the latest pattern and marking scheme issued by CBSE for the academic session 2019-20.

Practice Paper 2020

Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

(i) All questions are compulsory.
(ii) Section A: Q.no. 1 to 20 are very short answer questions (objective type) and carry 1 mark each.
(iii) Section B: Q.no. 21 to 27 are short answer questions and carry 2 marks each.
(iv) Section C: Q.no. 28 to 34 are long answer questions and carry 3 marks each.
(v) Section D: Q.no. 35 to 37 are also long answer questions and carry 5 marks each.
(vi) There is no overall choice. However an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
(vii) Use log tables if necessary, use of calculators is not allowed.

SECTION-A

Read the given passage and answer the questions 1 to 5 that follow :

In a coordination compound, the central metal atom or ion and the ligands that are directly attached to it form coordination sphere and the ions present outside the coordination sphere form ionisation sphere. When a coordination compound $CoCl_3 \cdot 6NH_3$ is mixed with $AgNO_3$, 3 moles of AgCl are precipitated per mole of the compound.

1. What is the structural formula of the complex?
2. Write down the IUPAC name of the complex.
3. What is the hybridisation of the central metal atom in the complex?
4. What will be the shape of the complex?
5. Is it diamagnetic or paramagnetic?

Questions 6 to 10 are one word answers :

6. Based on molecular forces what type of polymer is neoprene?
7. Name the type of potential difference produced between the fixed charge layer and diffused layer having opposite charge around the colloidal particles.
8. What is the unit of ebulioscopic constant?
9. What is the IUPAC name of the following compound?
   $HC \equiv C - CH_2OH$
10. What compound is formed when alkyl benzene is oxidised by alkaline $KMnO_4$?

Questions 11 to 15 are multiple choice questions :

11. Which one of the following does not involve coagulation?
    (a) Clotting of blood by the use of ferric chloride
    (b) Formation of delta region

(c) Treatment of drinking water by potash alum
(d) Peptization

12. The bakelite is prepared by the reaction between
(a) phenol and formaldehyde
(b) tetramethylene glycol and adipic acid
(c) urea and formaldehyde
(d) ethylene glycol and phthalic acid.

13. Saturated solution of KNO_3 is used to make 'salt bridge' because
(a) velocity of K^+ is greater than that of NO_3^-
(b) velocity of NO_3^- is greater than that of K^+
(c) velocities of both K^+ and NO_3^- are nearly the same
(d) KNO_3 is highly soluble in water.

14. The shape and hybridisation of some xenon oxyfluorides are given below. Choose the wrong set.
(a) $XeOF_2$ – T-Shape-sp^3d
(b) $XeOF_4$ – Square pyramidal-sp^3d^2
(c) XeO_2F_2 – Distored trigonal bipyramidal-sp^3d
(d) XeO_3F_2 – Octahedral-sp^3d

15. In the following reaction,

$$C_6H_5CH_2Br \xrightarrow[2.\ H_3O^+]{1.\ Mg,\ Ether} X$$, the product 'X' is

(a) $C_6H_5CH_2OCH_2C_6H_5$
(b) $C_6H_5CH_2OH$
(c) $C_6H_5CH_3$
(d) $C_6H_5CH_2CH_2C_6H_5$

Questions 16 to 20 :
(a) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
(b) Both assertion and reason are correct statements but reason is not the correct explanation of the assertion.
(c) Assertion is correct, but reason is wrong statement.
(d) Assertion is wrong, but reason is correct statement.

16. Assertion : Coagulation power of Al^{3+} is more than Na^+.
Reason : Greater the valency of the flocculating ion added, greater is its power to cause precipitation (Hardy-Schulze rule).

17. Assertion : Sulphide ores are concentrated by froth-floatation method.
Reason : Cresol stabilise the froth in froth-floatation method.

18. Assertion : Direct attachment of groups such as phenyl or vinyl to the carboxylic acid, increases the acidity of the carboxylic acid.
Reason : Resonance effect always increases the acidity of carboxylic acids.

19. Assertion : Haloalkanes show H-bonding.
Reason : Haloalkanes are insoluble in water.

20. Assertion : The reaction,

$$\underset{\text{Cane sugar}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

is a first order reaction.
Reason : Change in concentration of H_2O is negligible.

SECTION-B

21. The molar conductivity of acetic acid solution at infinite dilution is 390.7 Ω^{-1} cm^2 mol^{-1}. Calculate the molar conductivity of 0.01 M acetic acid solution, given that the dissociation constant of acetic acid is 1.8×10^{-5}.

OR

How much electricity in terms of Faradays is required to produce 20 g of calcium from molten $CaCl_2$?

22. The rate constant for an isomerisation reaction, $A \longrightarrow B$ is 4.5×10^{-3} min^{-1}. If the concentration of A is 1 M, calculate the rate of reaction after 1 h.

23. *tert*-Butylbromide reacts with aqueous NaOH by S_N1 mechanism while *n*-butyl bromide reacts by S_N2 mechanism. Why?

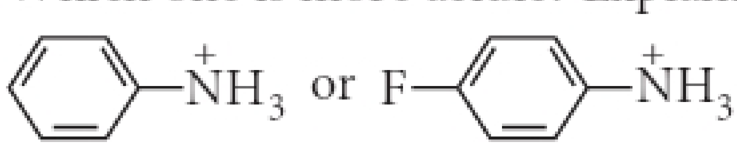
OR

Give the uses of (i) freon-12, (ii) DDT (iii) carbon tetrachloride and (iv) iodoform.

24. Give an example of a fuel cell and write the cathode and anode reactions for it.

25. The extraction of gold by leaching with NaCN involves both oxidation and reduction reactions. Justify it by giving chemical equations.

26. Which one is more acidic? Explain.



27. **(i)** Draw the structure of XeF_2.
(ii) Complete the following equation :
$XeF_4 + O_2F_2 \longrightarrow$

SECTION-C

28. How are the following conversions carried out?
(i) Benzyl chloride to benzyl alcohol
(ii) Ethyl magnesium chloride to propan-1-ol
(iii) Propene to propan-2-ol.

OR

An organic compound (A) reacts with PCl_5 to produce another compound (B). (B) reacts with magnesium metal in presence of ether to produce a Grignard reagent (C). (C) reacts with ethanal and the product is hydrolysed to produce propan-2-ol. Identify (A), (B) and (C), explain the reactions.

29. **(a)** Give reasons :

(i) Hydrogen fluoride is a weaker acid than hydrogen chloride in aqueous solution.

(ii) Bleaching of flowers by Cl_2 is permanent while that of SO_2 is temporary?

(b) Draw the structure of $H_2S_2O_7$.

30. **(i)** The rate of a chemical reaction doubles for an increase of 10 K in absolute temperature from 298 K. Calculate E_a.

(ii) Reactions having molecularity greater than three are not observed. Explain.

31. **(i)** What changes occur in the nature of egg proteins on boiling?

(ii) Define enzymes? What is the most important reason for their specific action?

32. What are antihistamines? Give two examples. Explain how do they act on the human body.

33. Two students use same stock solution of $ZnSO_4$ and $CuSO_4$. The e.m.f. of one cell is 0.03 V higher than the other. The concentration of $CuSO_4$ in the cell with higher e.m.f. value is 0.5 M. Find out the concentration of $CuSO_4$ in the other cell.
($2.303\ RT/F = 0.06$)

34. Give reasons :

(i) Amines are less acidic than alcohols of comparable molecular masses.

(ii) Primary amines have higher boiling point than tertiary amines.

(iii) Aryl diazonium salts are stable for a short time in solution at low temperature.

OR

Write the structures of compounds A, B and C in the following reactions :

(i) $CH_3{-}COOH \xrightarrow{NH_3/\Delta} A \xrightarrow{Br_2/KOH_{(aq.)}} B \xrightarrow{CHCl_3\ +\ \text{alc. KOH}} C$

(ii) $C_6H_5N_2^+BF_4^- \xrightarrow[\Delta]{NaNO_2/Cu} A \xrightarrow{Fe/HCl} B \xrightarrow{CH_3COCl/\text{pyridine}} C$

SECTION - D

35. **(i)** What is van't Hoff factor? What possible value can it have if the solute molecules undergo

(a) dissociation (b) association?

(ii) Determine the osmotic pressure of a solution prepared by dissolving 2.5×10^{-2} g of K_2SO_4 in 2 L of water at 25°C, assuming that it is completely dissociated.
($R = 0.0821$ L atm K^{-1} mol^{-1}, molar mass of $K_2SO_4 = 174$ g mol^{-1})

OR

(i) What happens when red blood corpuscles (RBC) are placed in

(a) 0.5% NaCl solution (b) 1% NaCl solution?

(ii) Heptane and octane form ideal solution. At 373 K, the vapour pressure of the two liquid components are 105.2 kPa and 46.8 kPa respectively. What will be the vapour pressure of a mixture of 26.0 g of heptane and 35.0 g of octane?

36. An organic compound (A) of molecular weight 140.5 has 68.32% carbon, 6.4% hydrogen and 25.26% chlorine. Hydrolysis of (A) with dilute acid gives compound (B), $C_8H_{10}O$. Compound (B) can be oxidised under mild conditions to form compound (C), C_8H_8O. Compound (C) forms a phenylhydrazone (D) with phenylhydrazine and gives positive iodoform test. Deduce the structures of (A) to (D) with proper reasoning.

OR

Account for the following :

(i) Aromatic carboxylic acids do not undergo Friedel–Crafts reaction.

(ii) pK_a value of 4-nitrobenzoic acid is lower than that of benzoic acid.

(iii) Write the reactions involved in the following:

(a) Hell—Volhard—Zelinsky reaction

(b) Decarboxylation reaction

(iv) Give simple chemical test to distinguish between the following pair of compounds: Benzoic acid and phenol

37. **(i)** A blackish brown coloured solid 'A' when fused with alkali metal hydroxides in presence of air, produces a dark green coloured compound 'B' which on electrolytic oxidation in alkaline medium gives a dark purple coloured compound 'C'. Identify A, B and C and write the reactions involved.

(ii) What happens when an acidic solution of the green compound (*B*) is allowed to stand for some time? Give the equation involved. What is this type of reaction called?

OR

(i) Account for the following :

(a) The enthalpies of atomisation of the transition metals are high.

(b) Silver bromide is used in photography.

(c) Cobalt(II) is stable in aqueous solution but in the presence of strong ligands, it is easily oxidised.

(b) When the ore of haematite is burnt in air with coke around 2000 °C along with lime, the process not only produces steel but also a silicate slag that is useful in making building materials such as cement. Discuss the same and show through balanced chemical equations.

SOLUTIONS

1. Structural formula : $[Co(NH_3)_6]Cl_3$

2. Hexaamminecobalt(III) chloride

3. d^2sp^3 hybridisation

4. Octahedral **5.** Diamagnetic

6. Elastomer **7.** Zeta-potential

8. K kg mol^{-1} **9.** Prop-2-yn-1-ol

10. Benzoic acid

11. (d) : Peptization is a process in which freshly formed precipitate converted to colloidal sol by adding suitable electrolyte (peptizing agent).

12. (a) **13. (c)** **14. (d)**

15. (c) : $C_6H_5CH_2Br \xrightarrow{\text{Mg, Ether}} C_6H_5CH_2MgBr$

$$C_6H_5CH_2MgBr \xrightarrow{H_3O^+} \underset{(X)}{C_6H_5CH_3} + Mg\begin{matrix} Br \\ OH \end{matrix}$$

16. (a)

17. (b) : Sulphide ores are wetted by oil thus become lighter and rise to the surface along with froth while impurities are wetted by water become heavier and settle down.

18. (c) : This is due to greater electronegativity of sp^2-hybridised carbon to which carboxyl carbon is attached.

19. (d) **20. (a)**

21. $\underset{C(1-\alpha)}{CH_3COOH} \rightleftharpoons \underset{C\alpha}{CH_3COO^-} + \underset{C\alpha}{H^+}$

$$K_{eq} = C\alpha^2 \text{ or } \alpha = \sqrt{\frac{K_{eq}}{C}} = \frac{\Lambda_m^c}{\Lambda_m^\infty}$$

$$\therefore \frac{\Lambda_m^c}{390.7} = \sqrt{\frac{1.8\times10^{-5}}{0.01}} = \sqrt{18\times10^{-4}} = 4.243\times10^{-2}$$

or $\Lambda_m^c = 16.57\ \Omega^{-1}\ cm^2\ mol^{-1}$

OR

Refer to answer 75, Page no. 40 (MTG CBSE Champion Chemistry Class 12).

22. Rate constant in min^{-1} shows that it is a reaction of 1^{st} order. Hence, $k = \frac{2.303}{t}\log\frac{[A]_0}{[A]}$

or $4.5\times10^{-3}\ min^{-1} = \frac{2.303}{60\ min}\log\frac{1}{[A]}$

or $\log[A] = -0.1172$ or $[A] = \text{Antilog}(-0.1172)$

$\therefore [A] = 0.7635\ mol\ L^{-1}$

This is the concentration after 1 h.

Rate (after 1 h) $= k[A] = 4.5\times10^{-3}\times0.7635\ mol\ L^{-1}\ min^{-1}$

$= 3.44\times10^{-3}\ mol\ L^{-1}\ min^{-1}$.

Form IV

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I, Mahabir Singh, authorised signatory for MTG Learning Media Pvt. Ltd. hereby declare that particulars given above are true to the best of my knowledge and belief.

For MTG Learning Media Pvt. Ltd.
Mahabir Singh
Director

23. *tert*-Butyl bromide reacts by S_N1 mechanism because due to steric hindrance, NaOH molecule cannot get attached to it and the carbocation produced in case of tertiary halide is more stable due to hyperconjugation hence, *tert*-butyl bromide reacts with NaOH by S_N1 mechanism while *n*-butyl bromide being primary halide undergoes S_N2 reaction.

OR

(i) CCl_2F_2 (Freon-12) is used in aerosol propellants, refrigerator and air conditioning.
(ii) DDT is used as an insecticide mainly against mosquitoes.
(iii) CCl_4 is used as a solvent, fire extinguisher and degreasing agent.
(iv) CHI_3 is used as an antiseptic.

24. *Refer to answers 93 and 97, Page no. 42* (MTG CBSE Champion Chemistry Class 12).

25. During the leaching process, Au is first oxidised to Au^+ by O_2 of the air which then combines with CN^- ions to form the soluble complex, sodium dicyanidoaurate(I).

$$\underset{\text{Gold (Impure)}}{4Au_{(s)}} + 8NaCN_{(aq.)} + 2H_2O_{(l)} + O_{2(g)} \longrightarrow \underset{\substack{\text{Sod. dicyanidoaurate(I)}\\ \text{(Soluble complex)}}}{4Na[Au(CN)_2]_{(aq.)}} + 4NaOH_{(aq.)}$$

Gold is then extracted from this complex, by displacement method (reduction) using a more electropositive metal *i.e.*, Zn. In this reaction, Zn acts as a reducing agent.

$$2Na[Au(CN)_2]_{(aq.)} + Zn_{(s)} \longrightarrow \underset{\text{Gold}}{2Au_{(s)}} + \underset{\text{Sod. tetracyanidozincate(II)}}{Na_2[Zn(CN)_4]_{(aq.)}}$$

26. Due to powerful –*I*-effect of the F-atom, it withdraws electrons from the $\overset{+}{N}H_3$ group. As a result, electron density in the N—H bond of *p*-fluoroanilinium ion decreases and hence release of a proton from *p*-fluoroanilium ion is much more easier than from anilinium ion. Therefore, *p*-fluoroanilinium ion is more acidic than anilinium ion.

27. (i) *Refer to answers 111, Page no. 111* (MTG CBSE Champion Chemistry Class 12).
(ii) Refer to answer 112 Page no. 111 (MTG CBSE Champion Chemistry Class 12).

28. (i) *Refer to answer 43 (ii), Page no. 185* (MTG CBSE Champion Chemistry Class 12).
(ii) *Refer to answer 68 (ii), Page no. 187* (MTG CBSE Champion Chemistry Class 12).
(iii) *Refer to answer 43 (i), Page no. 185* (MTG CBSE Champion Chemistry Class 12).

OR

Since, prop-2-ol is obtained by the action of a Grignard reagent (*C*) on ethanal followed by hydrolysis, therefore, Grignard reagent (*C*) must be CH_3MgCl.

$$\underset{\text{Methylmagnesium chloride}}{CH_3MgCl} + \underset{\text{Ethanal}}{CH_3CHO} \longrightarrow \left[CH_3-\overset{\overset{\displaystyle OMgBr}{|}}{C}H-CH_3\right] \xrightarrow{H^+/H_2O} \underset{\text{Propan-2-ol}}{CH_3-\overset{\overset{\displaystyle OH}{|}}{C}H-CH_3}$$

Since, CH_3MgCl is obtained by the action of Mg metal on compound (*B*), therefore, (*B*) must be methyl chloride, CH_3Cl.

$$\underset{\text{Methyl chloride }(B)}{CH_3Cl} + Mg \xrightarrow{\text{Ether}} \underset{\text{Methylmagnesium chloride }(C)}{CH_3MgCl}$$

Since, CH_3Cl is formed by the action of PCl_5 on compound (*A*), therefore, compound (*A*) must be methanol, CH_3OH.

$$\underset{\text{Methanol }(A)}{CH_3OH} + PCl_5 \longrightarrow \underset{\text{Methyl chloride }(B)}{CH_3Cl} + POCl_3 + HCl$$

29. (a) (i) Because of smaller size of F as compared to Cl, the bond dissociation energy of H—F bond is much higher than that of H—Cl bond. As a result, in aqueous solution, H—Cl bond can break more easily to form H^+ ion than H—F bond. Thus, hydrogen fluoride is a weaker acid than hydrogen chloride in aqueous solution.

(ii) *Refer to answer 78, Page no. 110* (MTG CBSE Champion Chemistry Class 12).

(b) *Refer to answer 36, Page no. 108* (MTG CBSE Champion Chemistry Class 12).

30. (i) Given : T_1 = 298 K, T_2 = 308 K, E_a = ?, $k_1 = k$ (say) then $k_2 = 2k$

Using Arrhenius equation, $\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

or $\log\frac{2}{1} = \frac{E_a}{2.303\times 8.314}\left[\frac{1}{298} - \frac{1}{308}\right]$

$$0.3010 = \frac{E_a}{2.303\times 8.314}\left[\frac{10}{298\times 308}\right]$$

$$E_a = \frac{0.3010\times 2.303\times 8.314\times 298\times 308}{10} = 52.897 \text{ kJ mol}^{-1}$$

(ii) The probability that more than three molecules can collide and react simultaneously is very small. Hence, the molecularity greater than three is not observed.

31. (i) On boiling, the globular proteins present in the egg undergo coagulation to form fibrous proteins.

As a result, proteins lose their biological activity and thus get denatured. Chemically, during denaturation, the secondary and tertiary structures of proteins are destroyed but primary structure remains intact.

(ii) Enzymes are biological catalysts. Chemically, they are globular (water soluble) proteins which have high molecular mass ranging from 15,000 to 1,000,000 g mol^{-1}. They are highly specific. This specificity is due to the presence of active sites of definite size and shape on their surfaces so that only specific substrates can fit into them.

32. The hypersensitivity of some persons towards certain drugs (penicillin, sulpha drugs), dust, pollen grains, etc. is called allergy. Allergy is caused by release of a substance called histamine in the body. Antihistamines are drugs which either reduce or inhibit the action of histamine in the body thereby preventing allergy. Two important antihistamine or anti-allergic drugs are brompheniramine and terfenadine. Histamines interact with the binding sites of receptor in the body to produce allergy. Antihistamines compete with histamines for these binding sites of receptor and thus, do not allow histamine to produce allergy. Thus, antihistamines are drugs which interfere with the natural action of histamine by competing for histamine binding sites of receptor.

33. The two cells may be represented as :

$Zn \mid Zn^{2+}$ (conc. = C) $\| Cu^{2+}$ (C_1 = ?) $\mid Cu$; $EMF = E_1$

$Zn \mid Zn^{2+}$ (conc. = C) $\| Cu^{2+}$ (0.5 M) $\mid Cu$; $EMF = E_2$

The cell reaction is $Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$

$$E_1 = E^\circ - \frac{2.303RT}{2F}\log\frac{C}{C_1}$$

$$E_2 = E^\circ - \frac{2.303RT}{2F}\log\frac{C}{0.5}$$

$$\therefore \; E_2 - E_1 = \frac{2.303\,RT}{2F}\left(\log\frac{C}{C_1} - \log\frac{C}{0.5}\right) = 0.03 \text{ V}$$

$$\therefore \; \frac{0.06}{2}\log\frac{0.5}{C_1} = 0.03 \text{ or } \log\frac{0.5}{C_1} = 1$$

$$\frac{0.5}{C_1} = 10 \text{ or } C_1 \text{ i.e., } [Cu^{2+}] = \frac{0.5}{10} = 0.05 \text{ M}$$

34. (i) Loss of a proton from an amine gives RNH^- ion while loss of a proton from alcohol gives RO^- ion as shown below :

$$R{-}NH_2 \longrightarrow R{-}NH^- + H^+$$

$$R{-}O{-}H \longrightarrow R{-}O^- + H^+$$

As O is more electronegative than N, RO^- can accommodate the negative charge more easily than the RNH^- can. As, RO^- is more stable than RNH^-, the former is formed more. As a result, amines are less acidic than alcohols.

(ii) In 1° amines, there is strong H-bonding that binds the amine molecules together. Whereas in 3° amine due to absence of H on N-atom prevents hydrogen bonding completely. This is why 1° amines have higher boiling point than 3° amines.

(iii) The stability of aryl diazonium salts is due to resonance stabilisation.

OR

(i) *Refer to answer 68 (ii), Page no. 231* (MTG CBSE Champion Chemistry Class 12).

(ii) *Refer to answer 83 (b), Page no. 233* (MTG CBSE Champion Chemistry Class 12).

35. (i) *Refer to answer 83 and 85, Page no. 20* (MTG CBSE Champion Chemistry Class 12).

(ii) *Refer to answer 94, Page no. 21* (MTG CBSE Champion Chemistry Class 12).

OR

(i) (a) The cells will swell or even brust due to haemolysis because 0.5% NaCl solution is hypotonic *w.r.t.* salt concentration in blood plasma.

(b) The cells will shrink due to plasmolysis, because 1% solution of NaCl is hypertonic *w.r.t.* salt concentration in blood plasma.

(ii) Molar mass of heptane (C_7H_{16}) = 100 g mol^{-1}

Molar mass of octane (C_8H_{18}) = 114 g mol^{-1}

$$\text{Number of moles of heptane} = \frac{26.0 \text{ g}}{100 \text{ g mol}^{-1}} = 0.26 \text{ mol}$$

$$\text{Number of moles of octane} = \frac{35.0 \text{ g}}{114 \text{ g mol}^{-1}} = 0.31 \text{ mol}$$

$$x\text{ (heptane)} = \frac{0.26}{0.26 + 0.31} = 0.456$$

x (octane) = 1 – 0.456 = 0.544

p(heptane) = 0.456 × 105.2 kPa = 47.97 kPa

p(octane) = 0.544 × 46.8 kPa = 25.46 kPa

P_{Total} = 47.97 + 25.46 = 73.43 kPa

36.

Element	Percentage of atoms	Relative number ratio	Simplest ratio
C	68.32	5.69	8
H	6.4	6.4	9
Cl	25.26	0.71	1

Therefore, empirical formula of compound (A) = C_8H_9Cl

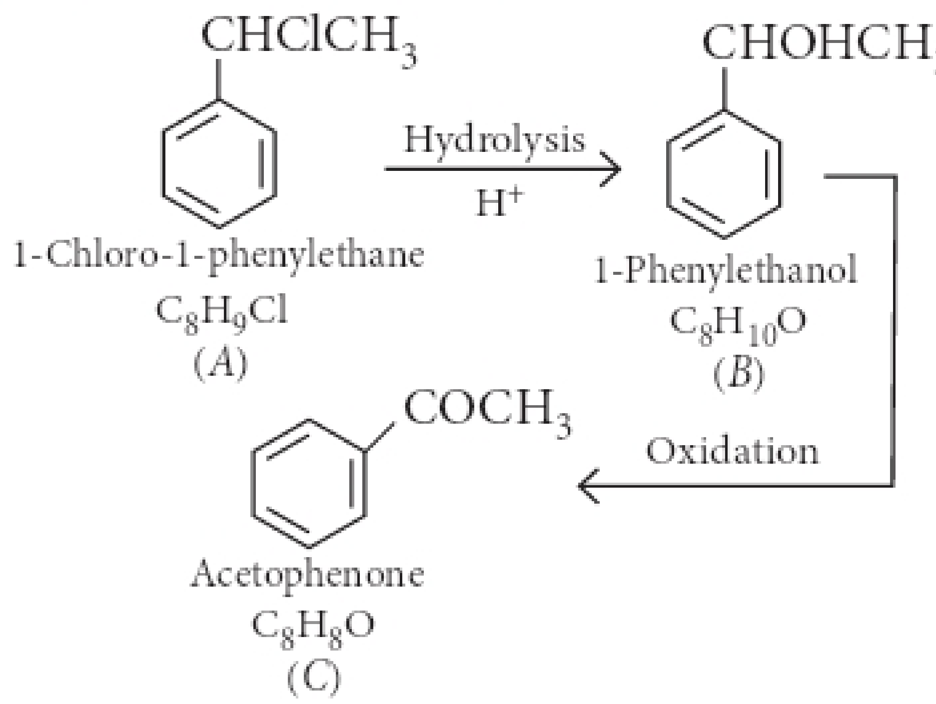
Empirical weight = 12 × 8 + 1 × 9 + 35.5 = 140.5

Molecular weight (given) = 140.5

As empirical formula weight and molecular weight are same,

$\therefore$ Molecular formula = C_8H_9Cl

Since (C) reacts with phenylhydrazine, therefore, it is a carbonyl compound. Since (C) gives positive iodoform test, it has $-COCH_3$ group. Thus, the probable structures of A, B, C and reactions are



OR

(i) *Refer to answer 131 (a), Page no. 214* (MTG CBSE Champion Chemistry Class 12).

(ii) *Refer to answer 131 (b), Page no. 214* (MTG CBSE Champion Chemistry Class 12).

(iii) (a) *Refer to answer 127, Page no. 214* (MTG CBSE Champion Chemistry Class 12).

(b) *Refer to answer 123, Page no. 214* (MTG CBSE Champion Chemistry Class 12).

(iv) *Refer to answer 133 (b), Page no. 214* (MTG CBSE Champion Chemistry Class 12).

37. (i) $\underset{\text{(A) Blackish brown}}{\underset{\text{Pyrolusite}}{MnO_2}} + 4KOH + O_2 \xrightarrow{\text{Fuse}} \underset{\text{(B) Green colour}}{\underset{\text{Potassium manganate}}{2K_2MnO_4}} + 2H_2O$

$\underset{(B)}{2K_2MnO_4} + H_2O + [O] \xrightarrow[\text{medium}]{\text{Alkaline}} \underset{\text{(C) Purple colour}}{\underset{\text{Potassium permanganate}}{2KMnO_4}} + 2KOH$

or $MnO_4^{2-} \longrightarrow MnO_4^- + e^-$

(ii) When acidic solution of green compound (B) *i.e.*, potassium manganate is allowed to stand for some time, it disproportionates to give permanganate as follows :

$3MnO_4^{2-} + 4H^+ \longrightarrow 2MnO_4^- + MnO_2 + 2H_2O$

This reaction is called disproportionation reaction.

OR

(i) (a) *Refer to answer 33 (i), Page no. 127* (MTG CBSE Champion Chemistry Class 12).

(b) Silver bromide is used in photography because of its sensitivity to sunlight. In light, AgBr reduces to metallic silver.

(c) *Refer to answer 23 (ii), Page no. 126* (MTG CBSE Champion Chemistry Class 12).

(ii) Following reactions occur when haematite is burnt with carbon (coke) and lime at 2000 °C.

$C + O_2 \longrightarrow CO_2$

$CO_2 + C \longrightarrow 2CO$

$3CO + Fe_2O_3 \longrightarrow \underset{\text{(Steel)}}{2Fe} + 3CO_2$ (Fe_2O_3 is reduced to Fe)

$\underset{\text{(Silica)}}{SiO_2} + \underset{\text{(Lime)}}{CaO} \longrightarrow \underset{\text{(Calcium silicate)}}{\underset{\text{(Slag)}}{CaSiO_3}}$

◆◆

Scientist who Made Us Proud

Hans Fischer was a German organic chemist and the recipient of the 1930 Nobel prize for chemistry "for his researches into the constitution of haemin and chlorophyll and especially for his synthesis of haemin".

In 1921 he held the position of Professor of organic chemistry at the technical university of Munich.



Hans Fischer

(27 July 1881 - 31 March 1945)

Biography

- Fischer was born in Höchst on Main, now a city district of Frankfurt. His parents were Dr. Eugen Fischer, director of the firm of Kalle & Co, Wiesbaden and Privatdozent at the technical high school. He read chemistry and medicine, first at the University of Lausanne and then at Marburg. He graduated in 1904 and in 1908 he qualified for his M.D.
- He worked first at a medical clinic in Munich and then at the first Berlin chemical institute under Emil Fischer. In 1913 he became a lecturer in physiology at the physiological institute in Munich. In 1916 he became professor of medical chemistry at the university of Innsbruck and from there he went to the university of Vienna in 1918.
- Fischer's scientific work was mostly concerned with the investigation of the pigments in blood, bile, and also chlorophyll in leaves, as well as with the chemistry of pyrrole from which these pigments are derived. Of special importance was his synthesis of bilirubin and haemin. The lunar crater Fischer was named after him (and Hermann Emil Fischer) in 1976.

Honours

- Fellow of the Academy of Sciences Leopoldina (1919)
- Privy Councillor (1925)
- Liebig Memorial Medal (1929)
- Nobel Prize for Chemistry (1930)
- Honorary doctorate, Harvard University (1936)
- Davy Medal of the Royal Society of London (1937)

MONTHLY TEST DRIVE

XII

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

The *d*- and *f*-Block Elements | Coordination Compounds

Total Marks : 120 **Time Taken : 60 Min.**

NEET

Only One Option Correct Type

1. The correct order of M—C π bond strength in the given metal carbonyls is

(a) $[Fe(CO)_4]^{2-} > [Co(CO)_4]^- > [Ni(CO)_4]$
(b) $[Ni(CO)_4] > [Co(CO)_4]^- > [Fe(CO)_4]^{2-}$
(c) $[Fe(CO)_4]^{2-} > [Ni(CO)_4] > [Co(CO)_4]^-$
(d) $[Ni(CO)_4] > [Co(CO)_4]^- = [Fe(CO)_4]^{2-}$

2. When $KMnO_4$ is added to oxalic acid, the decolorisation is slow in the beginning but becomes instantaneous after sometime because

(a) Mn^{2+} acts as an auto-catalyst
(b) CO_2 is formed as the product
(c) reaction is exothermic
(d) MnO_4^- catalyses the reaction.

3. For the following reaction sequence,

$(X) + K_2CO_3 + \text{Air} \xrightarrow{\text{Heat}} (Y)$

$(Y) + Cl_2 \longrightarrow (Z)$

which of the following is correct?

(a) $X = MnO_2$; Black, $Y = K_2CrO_4$; Blue, $Z = KMnO_4$; Purple
(b) $X = Cr_2O_3$; Green, $Y = K_2CrO_4$; Yellow, $Z = K_2Cr_2O_7$; Orange
(c) $X = MnO_2$; Black, $Y = K_2MnO_4$; Green, $Z = KMnO_4$; Purple
(d) $X = Bi_2O_3$; Black, $Y = KBiO_2$; Colourless, $Z = KBiO_3$; Green

4. The IUPAC name for $[Co(NCS)(NH_3)_5]Cl_2$ is

(a) pentaammine(thiocyanato-N)cobalt(III) chloride
(b) pentaammine(thiocyanato-S)cobalt(III) chloride
(c) pentaamine(isothiocyanato-N,S)cobalt(III) chloride
(d) pentaammine(mercapto-N)cobalt(III) chloride.

5. Identify the incorrect statement among the following.

(a) 4*f*- and 5*f*-orbitals are equally shielded.
(b) *d*-Block elements show irregular and erratic chemical properties among themselves.
(c) La and Lu have partially filled *d*-orbitals and no other partially filled orbitals.
(d) The chemistry of various lanthanoids is very similar.

6. $[Co(NH_3)_4(NO_2)_2]Cl$ exhibits

(a) linkage isomerism, ionisation isomerism and geometrical isomerism
(b) ionisation isomerism, geometrical isomerism and optical isomerism
(c) linkage isomerism, geometrical isomerism and optical isomerism
(d) linkage isomerism, ionisation isomerism and optical isomerism.

7. Amount of oxalic acid present in a solution can be determined by its titration with $KMnO_4$ solution in the presence of H_2SO_4. The titration gives unsatisfactory result when carried out in the presence of HCl, because HCl

(a) gets oxidised by oxalic acid to chlorine
(b) furnishes H^+ ions in addition to those from oxalic acid
(c) reduces permanganate to Mn^{2+}
(d) oxidises oxalic acid to carbon dioxide and water.

8. In nitroprusside ion, the iron exists as Fe^{2+} and NO as NO^+ rather than Fe^{3+} and NO respectively. These forms of ions are established with the help of

(a) magnetic moment in solid state
(b) thermal decomposition method
(c) by reaction with KCN
(d) by action with K_2SO_4.

9. $[Co_2(CO)_8]$ displays
(a) one Co—Co bond, six terminal CO and two bridging CO
(b) one Co—Co bond, four terminal CO and four bridging CO
(c) one Co—Co bond, two terminal CO and six bridging CO
(d) two Co—Co bond, five terminal CO and three bridging CO.

10. The correct order of ionic radii of Y^{3+}, La^{3+}, Eu^{3+} and Lu^{3+} is
(a) $La^{3+} < Eu^{3+} < Lu^{3+} < Y^{3+}$
(b) $Y^{3+} < La^{3+} < Eu^{3+} < Lu^{3+}$
(c) $Y^{3+} < Lu^{3+} < Eu^{3+} < La^{3+}$
(d) $Lu^{3+} < Eu^{3+} < La^{3+} < Y^{3+}$

11. Which of the following statements is correct?
(a) Geometrical isomerism is not observed in complexes of C.N. 4 having tetrahedral geometry.
(b) Square planar complexes generally do not show geometrical isomerism.
(c) The square planar complex of general formulae Ma_3b or Mab_3 exhibits *cis-trans* isomerism.
(d) The platinum glycinato complex, $[Pt(gly)_2]$ does not show geometrical isomerism.

12. The pair in which both species have same magnetic moment (spin only value) is
(a) $[Cr(H_2O)_6]^{2+}$, $[CoCl_4]^{2-}$
(b) $[Cr(H_2O)_6]^{2+}$, $[Fe(H_2O)_6]^{2+}$
(c) $[Mn(H_2O)_6]^{2+}$, $[Cr(H_2O)_6]^{2+}$
(d) $[CoCl_4]^{2-}$, $[Fe(H_2O)_6]^{2+}$

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** In octahedral complexes, three orbitals (d_{xy}, d_{yz}, d_{zx}) are stable and have low energy while the two orbitals ($d_{x^2-y^2}$, d_{z^2}) are unstable and have high energy.
Reason : In octahedral complexes, three *d*-orbitals (d_{xy}, d_{yz}, d_{zx}) experience less repulsion from the ligands while two *d*-orbitals ($d_{x^2-y^2}$, d_{z^2}) experience more repulsion from the ligands due to their shapes.

14. **Assertion :** $KMnO_4$ in aqueous solution is purple in colour due to charge transfer transition.
Reason : In MnO_4^- ion, there is no electron present in the *d*-orbital of Mn.

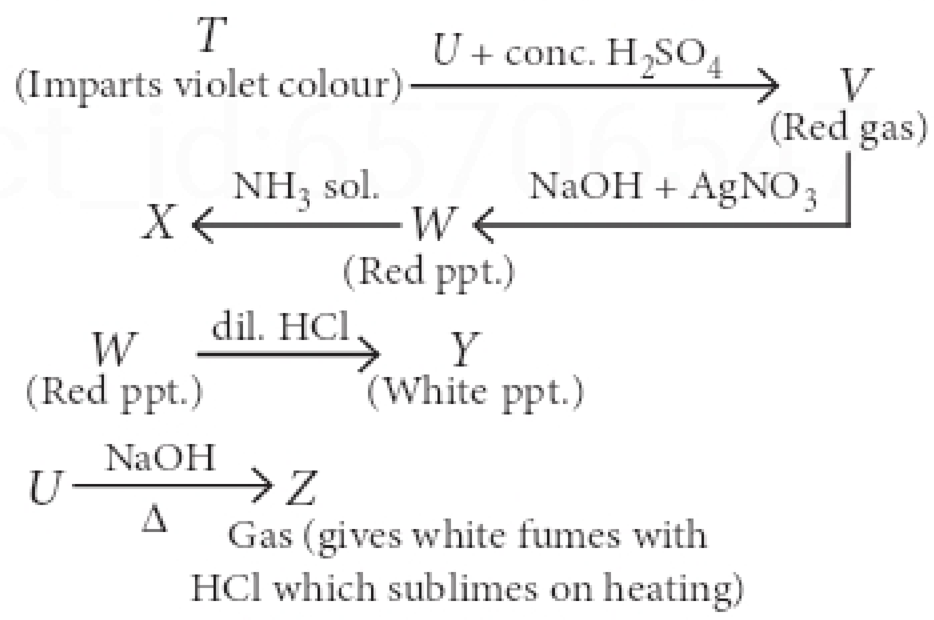
15. **Assertion:** $[Fe(H_2O)_6]^{3+}$ is strongly paramagnetic whereas $[Fe(CN)_6]^{3-}$ is weakly paramagnetic.
Reason : H_2O is a strong field ligand and CN^- is a weak field ligand.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. Which of the following statements is incorrect with respect to Fe^{2+} and Cu^{2+}?
(a) Both react with NaOH.
(b) Cu^{2+} gives blue ppt. of $Cu(OH)_2$ whereas Fe^{2+} gives green ppt. of $Fe(OH)_2$.
(c) Cu^{2+} gives chocolate brown ppt. whereas Fe^{2+} gives sky blue ppt. with $K_4[Fe(CN)_6]$.
(d) Both have four unpaired electrons.

17. $[Cr(H_2O)_6]Cl_3$ has a magnetic moment of 3.83 B.M. The correct distribution of 3*d*-electrons in the chromium present in the complex is
(a) $3d^1_{xy}, 3d^1_{yz}, 3d^1_{zx}$ (b) $3d^1_{xy}, 3d^1_{yz}, 3d^1_{z^2}$
(c) $3d^1_{(x^2-y^2)}, 3d^1_{z^2}, 3d^1_{zx}$ (d) $3d^1_{xy}, 3d^1_{(x^2-y^2)}, 3d^1_{xz}$

18.


Identify *T* to *Z*.
(a) $T = KMnO_4$, $U = HCl$, $V = Cl_2$, $W = HgI_2$, $X = Hg(NH_2)NO_3$, $Y = Hg_2Cl_2$, $Z = N_2$
(b) $T = K_2Cr_2O_7$, $U = NH_4Cl$, $V = CrO_2Cl_2$, $W = Ag_2CrO_4$, $X = [Ag(NH_3)_2]^+$, $Y = AgCl$, $Z = NH_3$
(c) $T = K_2CrO_4$, $U = KCl$, $V = CrO_2Cl_2$, $W = HgI_2$, $X = Na_2CrO_4$, $Y = BaCO_3$, $Z = NH_4Cl$
(d) $T = K_2MnO_4$, $U = NaCl$, $V = CrO_3$, $W = AgNO_2$, $X = (NH_4)_2CrO_4$, $Y = CaCO_3$, $Z = SO_2$

19. An octahedral complex with molecular composition $M{\cdot}5NH_3{\cdot}Cl{\cdot}SO_4$ has two isomers, *A* and *B*. The solution of *A* gives a white precipitate with $AgNO_3$ solution and the solution of *B* gives white precipitate with $BaCl_2$ solution. The type of isomerism exhibited by the complex is
(a) linkage isomerism (b) ionisation isomerism
(c) coordinate isomerism
(d) geometrical isomerism.

More than One Options Correct Type

20. Which of the following statements are correct?
(a) HgI_2 is red but turns yellow on heating above 400 K.
(b) HgI_2 is soluble in excess of KI solution.
(c) The interactions amongst Hg molecules are stronger than those between Hg and glass.
(d) Zinc oxide dissolves in excess of alkali.

21. Which of the following statements are correct about $[Fe(H_2O)_5NO]SO_4$?
(a) It is present in brown ring test for NO_3^-.
(b) Oxidation state of Fe is +1.
(c) Charge on NO is +1.
(d) Coordination number of Fe is 5.

22. Select correct statements regarding given complexes.
(a) $[Fe(CO)_5]$, the orbitals used for hybridisation in Fe atom are $s, p_x, p_y, p_z, d_{z^2}$ and it is high spin complex.
(b) $[Pt(NH_3)_2Cl_2]$, the orbitals used for hybridisation in Pt atom are $s, p_x, p_y, d_{x^2-y^2}$ and it is low spin complex.
(c) $[Cr(H_2O)_6]^{3+}$, the orbitals used for hybridisation in Cr atom are $s, p_x, p_y, p_z, d_{z^2}, d_{x^2-y^2}$ and it is high spin complex.
(d) $Ni(CO)_4$, the orbitals used for hybridisation in Ni atom are, s, p_x, p_y, p_z and it is low spin complex.

23. Reduction of the metal centre in aqueous permanganate ion involves
(a) 3 electrons in neutral medium
(b) 5 electrons in neutral medium
(c) 3 electrons in alkaline medium
(d) 5 electrons in acidic medium.

Numerical Value Type

24. Find the number of complexes which would produce 4 ions per formula unit of their most stable form on ionisation.
$CoCl_3 \cdot 3NH_3$, $PtCl_4 \cdot 2NH_3$, $PtCl_4 \cdot 2KCl$, $PtCl_4 \cdot NH_3$, $PtCl_2 \cdot 2NH_3$, $Fe(CN)_2 \cdot 4KCN$, $PtCl_4 \cdot 5NH_3$, $Fe(CN)_3 \cdot 3KCN$, $Co(NO_2)_3 \cdot 3KNO_2$

25. Amongst the following, the number of elements showing only + 3 oxidation state is
Ti, Sc, Cr, Y, Co, La, Ac, Fe, Th, Pt

26. What is the crystal field stabilization energy, in terms of Δ, for Zn^{2+} ion in a tetrahedral complex?

Matrix Match Type

Answer the following questions (27 and 28) by appropriately matching the columns based on the information given in the passage :

Valence bond theory explains magnetic behavior and geometrical shape of coordination compounds. Magnetic moment of a complex compound can be determined experimentally and theoretically by using spin only formula. Magnetic moment = $\sqrt{n(n+2)}$ B.M. (where n = No. of unpaired electrons).

	Column-I		Column-II
(P)	d^3 (octahedral)	I.	0.0 B.M.
(Q)	d^5 (octahedral, low spin)	II.	$2\sqrt{6}$ B.M.
(R)	d^6 (octahedral, low spin)	III.	$\sqrt{15}$ B.M.
(S)	d^6 (octahedral, outer orbital)	IV.	$\sqrt{3}$ B.M.

27. Which of the following has the correct combination considering column I and column II?
(a) P → III (b) Q → I (c) R → II (d) S → IV

28. Which of the following has the correct combination considering column-I and column-II?
(a) P → I (b) Q → III (c) R → IV (d) S → II

Answer the following questions (29 and 30) by appropriately matching the columns based on the information given in the passage :

$HgCl_2$ is a white crystalline compound. It is less soluble in cold water but more soluble in hot water. It behaves like a covalent compound as it is soluble in organic solvents and very slightly ionized in water. It is reduced by stannous chloride first into mercurous chloride and then into mercury.

	Column-I		Column-II
(P)	$HgCl_{2(aq.)}$ + NaOH	I.	Black ppt.
(Q)	$HgCl_{2(aq.)}$ + excess of $KI_{(aq.)}$	II.	White ppt.
(R)	KI + $HgCl_{2(aq.)}$ + $NH_{3(aq.)}$	III.	Yellow ppt.
(S)	$HgCl_{2(aq.)}$ + $SnCl_2$ (excess)	IV.	Colourless solution

29. Which of the following has the correct combination considering column-I and column-II?
(a) P → I (b) Q → IV (c) R → III (d) S → II

30. Which of the following has the correct combination considering column-I and column-II?
(a) P → I (b) Q → III (c) R → II (d) S → IV

◈◈

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted ……
No. of questions correct ……
Marks scored in percentage ……

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

GET SET GO *for* JEE



with exclusive and brain storming MCQs

Practicing these MCQs help to strengthen your concepts and give you extra edge in your JEE preparation

Only One Option Correct Type

1. In the reaction,

$$3Br_2 + 6CO_3^{2-} + 3H_2O \longrightarrow 5Br^- + BrO_3^- + 6HCO_3^-$$

(a) bromine is oxidised and carbonate is reduced
(b) bromine is reduced and water is oxidised
(c) bromine is neither reduced nor oxidised
(d) bromine is both reduced and oxidised.

2. In the following groups,

$-OAc$	$-OMe$	$-OSO_2Me$	$-OSO_2CF_3$
I	II	III	IV

the order of leaving groups ability is
(a) I > II > III > IV (b) IV > III > I > II
(c) III > II > I > IV (d) II > III > IV > I.

3. Al metal $\xrightarrow{HCl(aq.)}$ 'X' + Gas 'P'
Al metal $\xrightarrow{NaOH(aq.)}$ 'Y' + Gas 'Q'

The incorrect statement regarding the above reactions is
(a) Al shows amphoteric character
(b) gas 'P' and 'Q' are different
(c) both 'X' and 'Y' are water soluble
(d) gas 'Q' is inflammable.

4. Solubility product constant (K_{sp}) of salts of types MX, MX_2 and M_3X at temperature T are 4.0×10^{-8}, 3.2×10^{-14} and 2.7×10^{-15}, respectively. Solubilities (mol dm^{-3}) of the salts at temperature T are in the order
(a) $MX > MX_2 > M_3X$ (b) $M_3X > MX_2 > MX$
(c) $MX_2 > M_3X > MX$ (d) $MX > M_3X > MX_2$.

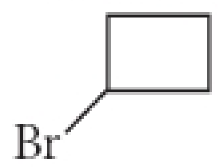
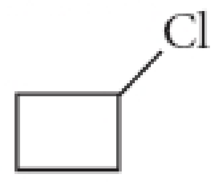
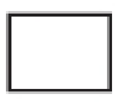
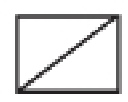
5. The ionisation potential of the ground state of hydrogen atom is 2.17×10^{-11} ergs per atom. What would be the wavelength of the photon that is emitted when an electron from 3rd Bohr orbit returns to 1st orbit in hydrogen atom?
(a) 1370 Å (b) 2737 Å
(c) 1026 Å (d) 8212 Å

6. Consider the following four elements, which are represented according to long form of the periodic table. Here W, Y and Z are left, up and right elements with respect to the element 'X' and 'X' belongs to 16th group and 3rd period. Then according to given information the incorrect statement regarding given elements is

	Y	
W	X	Z

(a) maximum electronegativity : *Y*
(b) maximum catenation property : *X*
(c) maximum electron affinity : *Z*
(d) *Y* exhibits more than two covalency.

7. What would be the product formed when 1-bromo-3-chlorocyclobutane reacts with two equivalents of metallic sodium in ether?

(a) 
(b) 
(c) 
(d) 

8. The solubility of metal halides depends on their nature, lattice enthalpy and hydration enthalpy of the individual ions. Amongst fluorides of alkali metals, the lowest solubility of LiF in water is due to
(a) ionic nature of lithium fluoride
(b) high lattice enthalpy
(c) high hydration enthalpy of lithium ion
(d) low ionisation enthalpy of lithium atom.

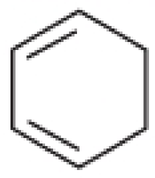
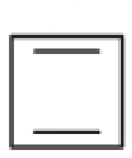
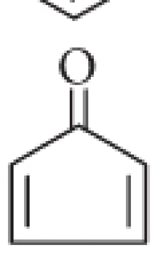
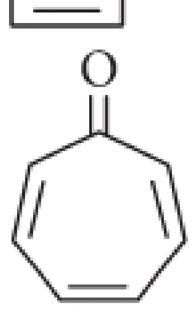
9. Which one of the following statements is correct?
(a) Extensive use of chemical fertilizers may lead to eutrophication of nearby water bodies.
(b) Both azotobacter and rhizobium fix atmospheric nitrogen in root nodules of plants.
(c) Cyanobacteria such as anabaena and nostoc are important mobilizers of phosphates and potassium for plant nutrition in soil.
(d) At present, it is not possible to grow maize without chemical fertilizers.

10. What weight of silver chloride will be precipitated when a solution containing 4.77 g of NaCl is added to a solution of 5.77 g of $AgNO_3$?
(a) 4.37 g (b) 4.87 g (c) 5.97 g (d) 3.87 g

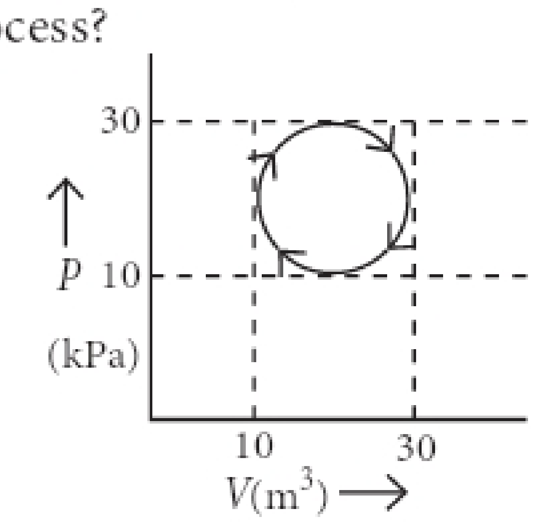
More Than One Options Correct Type

11. Which are true about H_2O_2?
(a) It acts both as an oxidising and reducing agent.
(b) Two — OH bonds lies in the same plane.
(c) It is a pale blue liquid.
(d) It can be oxidised by O_3.

12. Which of the following molecules, in pure form, are unstable at room temperature?

(a) 
(b) 
(c) 
(d) 

13. Which of the following values are correct for the cyclic process?



(a) $dU = 0$ (b) $q = -w$
(c) $w = 314$ J (d) $w = 31.4$ J

14. Which of the following have identical bond order?
(a) CN^- (b) O_2^- (c) NO^+ (d) CN^+

15. Which of the following statements are true?
(a) The ratio of the mean speed to the root mean square speed is independent of the temperature.
(b) The square of the mean speed of the molecules is equal to the square of the root mean square speed at a certain temperature.
(c) Mean kinetic energy of the gas molecules at any given temperature is independent of the mean speed.
(d) The difference between the root mean square speed and the mean speed at any temperature for different gases diminishes as larger, and yet larger molar masses are considered.

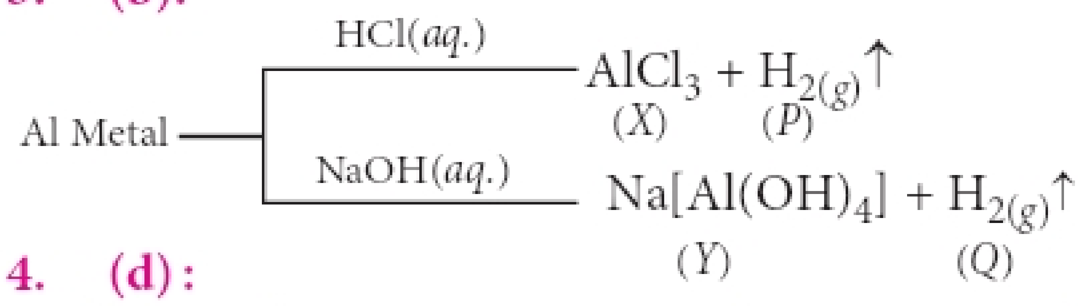
SOLUTIONS

1. **(d) :** It is a disproportionation reaction and hence, Br_2 is both reduced and oxidised.

2. **(b) :** Weaker the base better is the leaving ability. Since the conjugate acid of a weak base is stronger leaving group therefore, the correct arrangement in order of decreasing acidity is

$HOSO_2CF_3$ > $HOSO_2Me$ > HOAc > HOMe *i.e.,* IV > III > I > II.

3. (b):



4. (d):

Salt	Solubility product	Solubility
MX	$S_1^2 = 4.0 \times 10^{-8}$	$S_1 = 2 \times 10^{-4}$
MX_2	$4S_2^3 = 3.2 \times 10^{-14}$	$S_2 = 2 \times 10^{-5}$
M_3X	$27S_3^4 = 2.7 \times 10^{-15}$	$S_3 = 1 \times 10^{-4}$

Thus, solubility order is $MX > M_3X > MX_2$.

5. (c): $E = -2.17 \times 10^{-11}$ ergs per atom
$= -2.17 \times 10^{-18}$ J atom^{-1}

$$E_3 = -\frac{2.17\times10^{-18}}{3^2}\ \text{J atom}^{-1}$$

$$E_1 = \frac{-2.17\times10^{-18}}{1^2}\ \text{J atom}^{-1}$$

$$\Delta E = E_3 - E_1 = -\frac{2.17\times10^{-18}}{9} - (-2.17\times10^{-18})$$

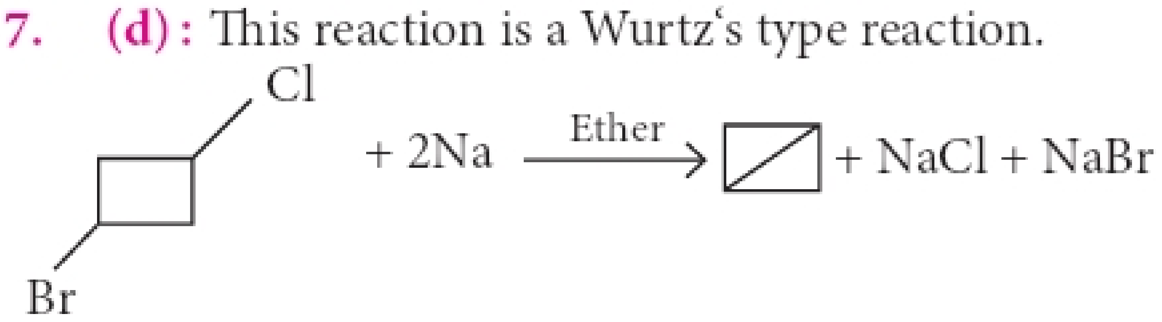
$$= 1.93 \times 10^{-18}\ \text{J atom}^{-1}$$

$$\Delta E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{6.6\times10^{-34}\times3\times10^{8}}{1.93\times10^{-18}}$$

$$= 10.26 \times 10^{-8}\ \text{m} = 1026\ \text{Å}$$

6. (d): W : Phosphorus Y : Oxygen
X : Sulphur Z : Chlorine
Electronegativity : O > Cl > S > P
Catenation : S > P > O > Cl
Electron Affinity : Cl > O > S > P
Oxygen exhibits covalency of two only.

7. (d): This reaction is a Wurtz's type reaction.



8. (b): Due to strong packing of Li^+ and F^- ions, lattice energy of LiF is higher than its hydration energy.

9. (a)

10. (b): According to the equation,

$$NaCl + AgNO_3 \longrightarrow NaNO_3 + AgCl$$

$$\text{Number of moles of NaCl} = \frac{4.77}{58.5} = 0.08126$$

$$\text{Number of moles of } AgNO_3 = \frac{5.77}{170} = 0.03394$$

Thus, $AgNO_3$ is the limiting reagent in the reaction.
1 mole of $AgNO_3$ produces 1 mole of AgCl,
0.03394 mole of $AgNO_3$ produces 0.03394 mole of AgCl.
$\therefore$ Weight of precipitated AgCl = 0.03394 × molecular mass of AgCl = 0.03394 × 143.5 = 4.87 g.

11. (a, c, d)

12. (b, c) : Options (b) and (c) are anti-aromatic molecules and unstable while (a) is non-aromatic and (d) is aromatic and stable at room temperature.

13. (a, b, c) : For a cyclic process, $dU = 0$

$\therefore\ q = \Delta U + (-w) \Rightarrow q = -w$

Also, w = Area covered by sphere = πr^2

$$= \pi \times \left[\frac{(V_2 - V_1)}{2}\right]^2 = \frac{\pi \times (20)^2}{2^2}$$

$= 100\ \pi = 100 \times 3.14 = 314$ J

14. (a, c) : Both CN^- and NO^+ have 14 electrons and their electronic configuration are same.

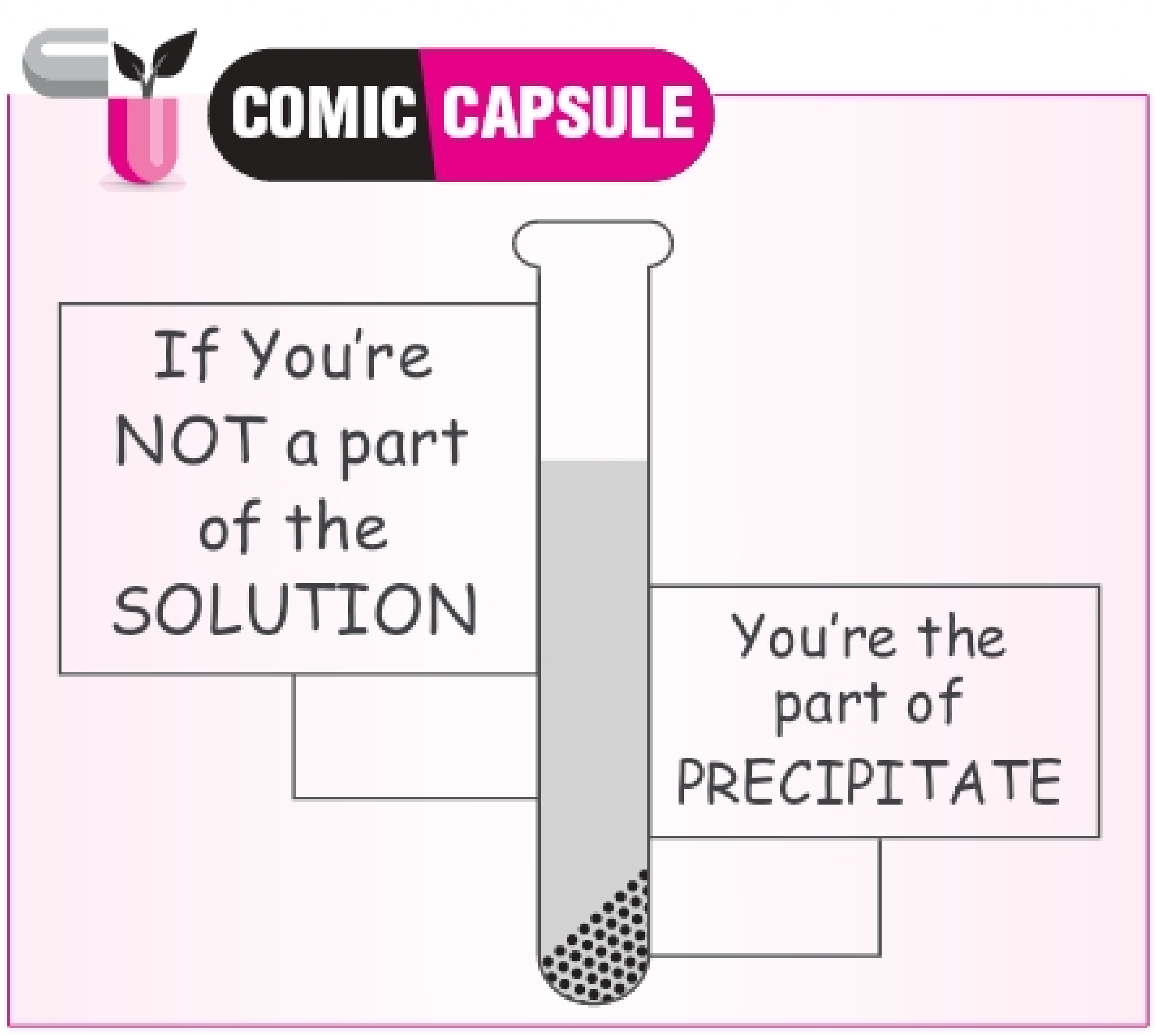
$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 \pi 2p_y^2$

Therefore, their bond order are same *i.e.,* 3.
The number of electrons in CN^+ and O_2^- are 12 and 17 respectively.

15. (a, c, d): $\dfrac{\mu_{av}}{\mu_{rms}} = \sqrt{\dfrac{8RT}{\pi M}} \Big/ \sqrt{\dfrac{3RT}{M}} = \sqrt{\dfrac{8}{3\pi}}$

Hence, the ratio of μ_{av} and μ_{rms} is independent of temperature.

$K.E._{av} = \frac{3}{2}RT$ (hence, it is independent of mean speed).



CLASS-XI

BRUSH UP for NEET/JEE 2020

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Unit 9 Principles Related to Practical Chemistry

Qualitative Salt Analysis

Identification of acidic and basic radicals in a salt can be carried out by performing various tests.

Preliminary Tests

Flame Test :

Salt with 1-2 drops of conc. HCl is introduced in the non-luminous (oxidising part) flame of the Bunsen burner using platinum wire.

- Greenish blue → Cu^{2+}
- Lilac → K^+
- Golden yellow → Na^+
- Brick red → Ca^{2+}
- Apple green → Ba^{2+}
- Crimson red → Sr^{2+}

Borax bead test

When borax is heated on a loop of Pt wire then colourless glassy bead of sodium metaborate and boric anhydride is formed.

$$Na_2B_4O_7\cdot10H_2O \xrightarrow{\Delta} Na_2B_4O_7 \xrightarrow{\Delta} \underbrace{2NaBO_2 + B_2O_3}_{\text{Glassy beads}}$$

Coloured salts are then heated on the glassy bead to form coloured metaborate.

Metal	Colour in			
	Oxidising flame		Reducing flame	
	Hot	Cold	Hot	Cold
Copper	Green	Blue	Colourless	Brown red
Iron	Brown-yellow	Pale yellow	Bottle green	Bottle green
Chromium	Green	Green	Green	Green
Cobalt	Blue	Blue	Blue	Blue
Manganese	Violet	Amethyst red	Colourless	Colourless
Nickel	Red-brown	Brown	Grey	Grey

Identification of Acidic Radicals

Anions are acidic radicals.

- **First group**: CO_3^{2-}, S^{2-}, SO_3^{2-}, CH_3COO^-, $S_2O_3^{2-}$, NO_2^-. Reagent used : dil. HCl
- **Second group**: Br^-, Cl^-, I^-, NO_3^-, $C_2O_4^{2-}$. Reagent used : conc. H_2SO_4
- **Third group**: SO_4^{2-}, PO_4^{3-}. Reagent used : dil. HCl/conc. H_2SO_4

First Group (I) :

Salt + dil. HCl

Effervescence or evolution of gas shows presence of group I acidic radicals.

- Colourless gas with suffocating smell with yellow ppt. of sulphur $\xrightarrow{\text{Pass through } K_2Cr_2O_7}$ Blackish green solution $\longrightarrow S_2O_3^{2-}$ confirmed
- Brown gas (NO_2) $\xrightarrow{\text{Starch iodide paper}}$ Blue $\longrightarrow NO_2^-$ confirmed
- Colourless gas with vinegar smell (CH_3COO^- may be present) Salt solution + $FeCl_3$ (neutral) $\longrightarrow \underset{\text{Blood red colour solution}}{(CH_3COO)_3Fe} \longrightarrow CH_3COO^-$ confirmed
- Colourless gas with suffocating smell (SO_2) $\xrightarrow{\text{Heat and pass through } K_2Cr_2O_7}$ Solution turns green due to $Cr_2(SO_4)_3 \longrightarrow SO_3^{2-}$ confirmed
- Colourless gas with rotten egg smell (H_2S gas) $\xrightarrow{\text{Lead acetate}} \underset{\text{Black ppt.}}{PbS} \longrightarrow S^{2-}$ confirmed
- Colourless, odourless gas (CO_2 gas) $\xrightarrow{\text{Lime water}} \underset{\text{Milky}}{CaCO_3}$ (CO_3^{2-} or HCO_3^- may be present)
- Confirmatory test for HCO_3^- and CO_3^{2-}

  Salt + water $\longrightarrow$ boil and pass through lime water
  - Lime water does not turn milky $\downarrow$ HCO_3^- confirmed
  - Lime water turns milky $\downarrow$ CO_3^{2-} confirmed

Second Group (II) :

Salt + conc. H_2SO_4

Effervescence or evolution of gases indicates the presence of group II acidic radicals.

Gas	Radical	Observations and Reactions
HCl (Colourless gas, pungent smell)	Chloride (Cl^-)	$\underset{\text{Salt}}{NaCl} + H_2SO_4 \rightarrow NaHSO_4 + HCl\uparrow$ $NH_4OH + HCl \rightarrow \underset{\text{White dense fumes}}{NH_4Cl\uparrow} + H_2O$
Br_2 (Brown fumes)	Bromide (Br^-)	$\underset{\text{Salt}}{NaBr} + H_2SO_4 \rightarrow NaHSO_4 + HBr$ $2HBr + H_2SO_4 \rightarrow \underset{\text{Brown}}{Br_2\uparrow} + 2H_2O + SO_2$
I_2 (Deep violet gas)	Iodide (I^-)	$\underset{\text{Salt}}{2KI} + 2H_2SO_4 \rightarrow 2KHSO_4 + 2HI$ $2HI + H_2SO_4 \rightarrow \underset{\text{Violet}}{I_2\uparrow} + SO_2 + 2H_2O$
NO_2 (Light brown gas, pungent smell)	Nitrate (NO_3^-)	$\underset{\text{Salt}}{NaNO_3} + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$ $4HNO_3 \rightarrow 2H_2O + \underset{\text{Light brown fumes}}{4NO_2\uparrow} + O_2\uparrow$
CO + CO_2 (Colourless, odourless gas)	Oxalate ($C_2O_4^{2-}$)	$\underset{\text{Salt}}{Na_2C_2O_4} + H_2SO_4 \rightarrow Na_2SO_4 + H_2C_2O_4$ $H_2C_2O_4 + H_2SO_4 \rightarrow \underset{\text{Burns with blue flame}}{CO} + \underset{\text{Turns lime water milky}}{CO_2} + H_2O$

- **Confirmatory Tests for Group II :**

Confirmatory tests for acid radicals of group II

Nitrate (NO_3^-)

Brown ring test : On treating aqueous solution of salt with freshly prepared solution of ferrous sulphate and concentrated sulphuric acid, gives a brown ring at the junction of two liquids.

$\underset{\text{Salt}}{NaNO_3} + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3$

$6FeSO_4 + 2HNO_3 + 3H_2SO_4 \longrightarrow 3Fe_2(SO_4)_3 + 4H_2O + 2NO$

$[Fe(H_2O)_6]SO_4 + NO \longrightarrow \underset{\text{Brown ring}}{[Fe(H_2O)_5NO]SO_4} + H_2O$

Oxalate ($C_2O_4^{2-}$)

On acidifying salt solution or sodium carbonate extract with acetic acid and on adding calcium chloride solution gives white precipitate.

$\underset{\text{Salt}}{Na_2C_2O_4} + CaCl_2 \longrightarrow \underset{\text{White ppt.}}{CaC_2O_4\downarrow} + 2NaCl$

Filter and dissolve the precipitate in dilute sulphuric acid and add few drops of potassium permanganate solution.

$CaC_2O_4 + H_2SO_4 \longrightarrow H_2C_2O_4 + CaSO_4$

$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$

$\begin{matrix} COOH \\ | \\ COOH \end{matrix} + [O] \longrightarrow 2CO_2 + H_2O$

Pink colour discharge of $KMnO_4$ confirming presence of oxalate ion.

Chloride (Cl^-)

Chromyl chloride test :

$\underset{\text{Salt}}{NaCl} + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

$K_2Cr_2O_7 + 2H_2SO_4 \longrightarrow 2KHSO_4 + 2CrO_3 + H_2O$

$CrO_3 + 2HCl \longrightarrow \underset{\text{Chromyl chloride (Red vapours)}}{CrO_2Cl_2\uparrow} + H_2O$

These vapours on passing through sodium hydroxide solution give yellow solution of sodium chromate.

$CrO_2Cl_2 + 4NaOH \longrightarrow \underset{\text{Yellow colour}}{Na_2CrO_4} + 2NaCl + 2H_2O$

The yellow solution on neutralising with acetic acid and on addition of lead acetate gives yellow precipitate of lead chromate.

$Na_2CrO_4 + (CH_3COO)_2Pb \longrightarrow \underset{\text{Yellow ppt.}}{PbCrO_4\downarrow} + 2CH_3COONa$

Iodide (I^-)

Layer test : On treating salt with dilute sulphuric acid, chloroform or carbon tetrachloride and chlorine water, gives violet coloured layer.

$\underset{\text{Salt}}{2NaI} + Cl_2 \longrightarrow 2NaCl + I_2$

I_2 + Chloroform $\longrightarrow$ Violet coloured layer

Starch paper test :

I_2 + Starch $\longrightarrow$ I_2-starch complex (Blue colour)

Bromide (Br^-)

Layer test : On treating salt with dilute sulphuric acid, chloroform or carbon tetrachloride and chlorine water gives brown coloured layer.

$\underset{\text{Salt}}{2NaBr} + Cl_2 \longrightarrow 2NaCl + Br_2$

Br_2 + Chloroform $\longrightarrow$ Brown coloured layer

Third Group (III) :

These anions are identified by their characteristic chemical reactions.

- Salt $\xrightarrow[\text{dil. HCl}]{BaCl_2}$ $BaSO_4$ White ppt. (Insoluble in dil. HCl) → SO_4^{2-} confirmed (Sulphate)
- Salt $\xrightarrow[C_2H_5OH]{H_2SO_4}$ $(C_2H_5)_3BO_3$ Burns with green edged flame → BO_3^{3-} confirmed (Borate)
- Salt $\xrightarrow{\text{dil. } HNO_3 \text{ + ammonium molybdate}}$ $(NH_4)_3PO_4\cdot 12MoO_3$ (Canary yellow ppt.) → PO_4^{3-} confirmed (Phosphate)

Identification of Basic Radicals

- **Separation of basic radicals into different groups :**

Basic radicals of	Group reagent	Precipitated as	Explanation
Group I Ag^+, Pb^{2+}, Hg_2^{2+}	dil. HCl	$AgCl, PbCl_2, Hg_2Cl_2$ (All white)	K_{sp} values of their chlorides are low, hence $K_{ip} > K_{sp}$ and they get precipitated.

Group II Hg^{2+}, Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Sn^{4+}	H_2S in presence of dil. HCl	HgS, PbS, Bi_2S_3, CuS (Black); CdS, As_2S_3, SnS_2 (Yellow); Sb_2S_3 (Orange); SnS (Brown)	HCl (with common H^+ ion) decreases the ionization of H_2S which gives low $[S^{2-}]$. Hence, only group II sulphides having low K_{sp} values are precipitated.
Group III Fe^{3+}, Cr^{3+}, Al^{3+}	NH_4OH in presence of NH_4Cl	$Fe(OH)_3$ (Reddish brown), $Cr(OH)_3$ (Green), $Al(OH)_3$ (White)	NH_4Cl (with common NH_4^+ ion) decreases the ionization of NH_4OH giving low $[OH^-]$. Hence, only group III hydroxides having low K_{sp} values are precipitated.
Group IV Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}	H_2S in presence of NH_4OH	ZnS (Greenish white), MnS (Buff), CoS, NiS (Black),	Basic medium increases the ionization of H_2S, thus increasing $[S^{2-}]$, hence precipitation of group IV sulphides having high K_{sp} values occurs.
Group V Ba^{2+}, Sr^{2+}, Ca^{2+}	$(NH_4)_2CO_3$ in presence of NH_4OH	$BaCO_3$, $SrCO_3$, $CaCO_3$ (All white)	K_{sp} values of their carbonates are less than that of group VI (Mg^{2+}) hence, group V is precipitated before Mg^{2+}.
Group VI Mg^{2+}	Na_2HPO_4 in presence of NH_4OH	$Mg(NH_4)PO_4$ (White)	—
Zero NH_4^+	NaOH	Ammonia gas is evolved.	Tested independently from original solution.

Quantitative Analysis

Titration

The process of addition of the known solution from the burette to the measured volume of solution of the substance to be estimated until the reaction between the two is just complete.

Acid-Base Titration

- When the strength of an acid is determined with the help of a standard solution of base, it is known as acidimetry.
- When the strength of a base is determined with the help of a standard solution of an acid, it is known as alkalimetry.

These titrations involve neutralisation of an acid with an alkali.

$$\underset{\text{Acid}}{HA} + \underset{\text{Alkali}}{BOH} \longrightarrow \underset{\text{Salt}}{BA} + \underset{\text{Water}}{H_2O}$$

Calculations Involving in Volumetric Analysis

Number of equivalents = Normality (N) × Volume (V) (in L)

Number of equivalents of titrate *i.e.*,

$N_1V_1 = N_2V_2$ = Number of equivalents of titrant

The above equation is known as normality equation.

Similarly, molarity equation is also given but it is usually applicable for dilution of a solution.

$M_1V_1 = M_2V_2$; Normality = Molarity × n,

where n = valency factor

Thus, $N_1V_1 = N_2V_2$ can be written as : $M_1V_1n_1 = M_2V_2n_2$

Indicator

A substance which helps in physical detection of completion of the titration is called indicator.

Some common acid-base indicators			
Indicator colour change, from acidic to alkaline medium	**$pK_{(ind)}$**	**pH range**	**Example of titration**
Methyl orange (red ⇒ yellow)	3.7	3.2 – 4.4	Weak base *vs* strong acid titration
Methyl red (red ⇒ yellow)	5.1	4.2 – 6.3	Weak base *vs* strong acid titration
Phenol red (yellow ⇒ red)	7.9	6.4 – 8.2	Strong acid *vs* strong base titration
Phenolphthalein (colourless ⇒ pink)	9.3	8.3 – 10.0	Weak acid *vs* strong base titration

PEEP INTO PREVIOUS YEARS

1. The cation that will not be precipitated by H_2S in the presence of dil. HCl is
   (a) Cu^{2+} (b) Pb^{2+}
   (c) As^{3+} (d) Co^{2+}
   (Online JEE Main 2015)

2. For standardising NaOH solution, which of the following is used as a primary standard?
   (a) Oxalic acid
   (b) Ferrous ammonium sulphate
   (c) Sodium tetraborate
   (d) Dil. HCl *(Online JEE Main 2018)*

3. An alkali is titrated against an acid with methyl orange as indicator, which of the following is a correct combination?

	Base	Acid	End point
(a)	Weak	Strong	Colourless to pink
(b)	Strong	Strong	Pinkish red to yellow
(c)	Weak	Strong	Yellow to pinkish red
(d)	Strong	Strong	Pink to colourless

(JEE Main 2018)

4. Which will make basic buffer?
   (a) 100 mL of 0.1 M HCl + 100 mL of 0.1 M NaOH
   (b) 50 mL of 0.1 M NaOH + 25 mL of 0.1 M CH_3COOH
   (c) 100 mL of 0.1 M CH_3COOH + 100 mL of 0.1 M NaOH
   (d) 100 mL of 0.1 M HCl + 200 mL of 0.1 M NH_4OH *(NEET 2019)*

QUALITATIVE ANALYSIS OF ORGANIC COMPOUNDS

Detection of N, S, Cl in Organic Compounds

Lassaigne's extract : A small pellet of metallic sodium together with a little amount of the substance is heated to red hot in an ignition tube. It is then suddenly plunged into about 10 mL of distilled water in a China dish. The mixture is boiled well and filtered. Filtrate is known as Lassaigne's extract (L.E.).

Element	Detection	Confirmatory test	Reactions
Nitrogen	Lassaigne's extract (L.E.) $Na + C + N \xrightarrow{\Delta} \underset{(L.E.)}{NaCN}$	L.E. + $FeSO_4$ + NaOH, boil and cool + $FeCl_3$ + conc. HCl Gives blue or green colour.	$FeSO_4 + 2NaOH \longrightarrow Fe(OH)_2 + Na_2SO_4$ $Fe(OH)_2 + 6NaCN \longrightarrow Na_4[Fe(CN)_6] + 2NaOH$ $Na_4[Fe(CN)_6] + FeCl_3 \xrightarrow{HCl} \underset{\text{Prussian blue}}{NaFe[Fe(CN)_6]} + 3NaCl$ or $3Na_4[Fe(CN)_6] + 4FeCl_3 \longrightarrow \underset{\text{Prussian blue}}{Fe_4[Fe(CN)_6]_3} + 12NaCl$
Sulphur	$2Na + S \xrightarrow{\Delta} \underset{(L.E.)}{Na_2S}$	(i) L.E. + sodium nitroprusside A deep violet colour. (ii) L.E. + CH_3COOH + $(CH_3COO)_2Pb$ Gives a black ppt.	(i) $Na_2S + \underset{\text{Sodium nitroprusside}}{Na_2[Fe(CN)_5NO]} \longrightarrow \underset{\text{Deep violet}}{Na_4[Fe(CN)_5NOS]}$ (ii) $Na_2S + (CH_3COO)_2Pb \xrightarrow{CH_3COOH} \underset{\text{Black ppt.}}{PbS\downarrow} + 2CH_3COONa$
Halogens	$Na + X \xrightarrow{\Delta} \underset{(L.E.)}{NaX}$ (X = Cl, Br, I)	L.E. + HNO_3 + $AgNO_3$ (i) White ppt. soluble in aq. NH_3 (or NH_4OH) confirms Cl. (ii) Pale yellow ppt. partially soluble in aq. NH_3 (or NH_4OH) confirms Br. (iii) Yellow ppt. insoluble in aq. NH_3 (or NH_4OH) confirms I.	$NaX + AgNO_3 \xrightarrow{HNO_3} \underset{\text{White ppt.}}{AgX\downarrow} + NaNO_3$ $AgCl + 2NH_4OH_{(aq.)} \longrightarrow \underset{\text{Soluble}}{[Ag(NH_3)_2]Cl} + 2H_2O$
Nitrogen and sulphur together	$Na + C + N + S \xrightarrow{\Delta} \underset{(L.E.)}{NaSCN}$ Sodium thiocyanate	As in test for nitrogen; instead of green or blue colour, blood red colouration confirms the presence of N and S both.	$3NaSCN + FeCl_3 \longrightarrow \underset{\text{Blood red colour}}{[Fe(SCN)_3]} + 3NaCl$

Quantitative Analysis of Organic Compounds

Element	Method
Carbon and Hydrogen	**Liebig's Combustion method :** A known mass of an organic compound is burnt in the presence of excess of O_2 and CuO. $C_xH_y + \left(x+\frac{y}{4}\right)O_2 \xrightarrow{\Delta} xCO_2 + \frac{y}{2}H_2O$ CO_2 evolved is absorbed by conc. solution of KOH or ascarite (NaOH + CaO). H_2O produced is absorbed by anhydrous $CaCl_2$ or $Mg(ClO_4)_2$. Increase in masses of these absorbing compounds gives the masses of CO_2 and H_2O produced. $\% \text{ of C} = \frac{12}{44}\times\frac{\text{Mass of } CO_2 \text{ formed}}{\text{Mass of compound taken}}\times 100$, $\% \text{ of H} = \frac{2}{18}\times\frac{\text{Mass of } H_2O \text{ formed}}{\text{Mass of compound taken}}\times 100$
Nitrogen	(i) **Dumas method :** Nitrogen containing organic compound is heated with CuO in an atmosphere of CO_2. $C_xH_yN_z + \left(2x+\frac{y}{2}\right)CuO \longrightarrow xCO_2 + \frac{y}{2}H_2O + \frac{z}{2}N_2 + \left(2x+\frac{y}{2}\right)Cu$ N_2 evolved gets collected over conc. KOH solution which absorbs all other gases. $\% \text{ of N} = \frac{28}{22400}\times\frac{\text{Vol. of } N_2 \text{ at STP}}{\text{Mass of compound taken}}\times 100$, $\% \text{ of N} = \frac{1.4\times\text{Normality of acid}\times\text{Vol. of acid used}}{\text{Mass of compound taken}}$ (ii) **Kjeldahl's method :** Organic compound + $H_2SO_{4\,(conc.)} \longrightarrow (NH_4)_2SO_4 \xrightarrow{2NaOH} Na_2SO_4 + 2NH_3 + 2H_2O$ $2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$ $\% \text{ of N} = \frac{1.4\times\text{Molarity of acid}\times\text{Vol. of acid used}\times\text{Basicity of acid}}{\text{Mass of compound taken}}$
Halogens	**Carius method :** Halogen in organic compound is precipitated as silver halide by boiling with conc. HNO_3 and then adding $AgNO_3$. $X \xrightarrow[AgNO_3]{HNO_3,\,\Delta} AgX\downarrow$ $\% \text{ of Cl} = \frac{35.5}{143.5}\times\frac{\text{Mass of AgCl formed}}{\text{Mass of compound taken}}\times 100$ $\% \text{ of Br} = \frac{80}{188}\times\frac{\text{Mass of AgBr formed}}{\text{Mass of compound taken}}\times 100$, $\% \text{ of I} = \frac{127}{235}\times\frac{\text{Mass of AgI formed}}{\text{Mass of compound taken}}\times 100$
Sulphur	**Carius method :** Sulphur in organic compound is converted into H_2SO_4 by boiling with Na_2O_2 or conc. HNO_3 and is precipitated as $BaSO_4$ by adding excess of $BaCl_2$ solution in water. $S \xrightarrow[\text{(ii) } BaCl_2]{\text{(i) } HNO_3,\,\Delta} \underset{\text{White ppt.}}{BaSO_4\downarrow}$ $\% \text{ of S} = \frac{32}{233}\times\frac{\text{Mass of } BaSO_4 \text{ formed}}{\text{Mass of compound taken}}\times 100$

Oxygen	**Iodine method :** Organic compound $\xrightarrow{\Delta}$ O_2 + Other gaseous products $[2C + O_2 \xrightarrow{1373\ K} 2CO] \times 5$ $[I_2O_5 + 5CO \longrightarrow I_2 + 5CO_2] \times 2$ $10C + 5O_2 + 2I_2O_5 \longrightarrow 10CO_2 + 2I_2$ $\%\text{ of O} = \frac{32}{88} \times \frac{\text{Mass of } CO_2 \text{ formed}}{\text{Mass of compound taken}} \times 100$; $\%\text{ of O} = \frac{5\times16}{2\times127} \times \frac{\text{Mass of } I_2 \text{ formed}}{\text{Mass of compound taken}} \times 100$

PEEP INTO PREVIOUS YEARS

5. In Carius method of estimation of halogens, 250 mg of an organic compound gave 141 mg of AgBr. The percentage of bromine in the compound is (At. mass of Ag = 108; Br = 80)
(a) 48 (b) 60
(c) 24 (d) 36 *(JEE Main 2015)*

6. Sodium extract is heated with concentrated HNO_3 before testing for halogens because
(a) Ag_2S and AgCN are soluble in acidic medium
(b) silver halides are totally insoluble in nitric acid
(c) S^{2-} and CN^-, if present, are decomposed by conc. HNO_3 and hence do not interfere in the test
(d) Ag reacts faster with halides in acidic medium.
(Online JEE Main 2016)

POINTS FOR EXTRA SCORING

- Blood is a buffer containing carbonic acid (H_2CO_3) and bicarbonate ions (HCO_3^-), small amounts of the acid or base produced from the spicy food do not disturb its pH.
- Indicator used in acid-base titration should be such that $pK_{Indicator}$ = pH at the equivalent point.
- For a colour change of an indicator, pH = $pK_{Indicator}$ ±1, *i.e.*, indicator have a useful colour change over a pH range of 2 units.
- In the titration of a weak acid, at half the equivalence point (half-neutralisation), pH = pK_a.
- Messenger's method is used for estimation of sulphur. It this method, the organic compound is heated with alkaline $KMnO_4$ solution when sulphur present in the organic compound is oxidised to K_2SO_4 which is then estimated as $BaSO_4$.
- Rectified spirit contains about 95% alcohol (b.p. 351 K) and 5% water (b.p. 373 K) but alcohol and water cannot be separated from this mixture even though their boiling points to differ by 22 K. To remove water from such mixture (alcohol and water) azeotropic distillation is used.

Answer Key For Peep Into Previous Years

1.	(d)	2.	(a)	3.	(c)	4.	(d)	5.	(c)	6.	(c)

WRAP it up!

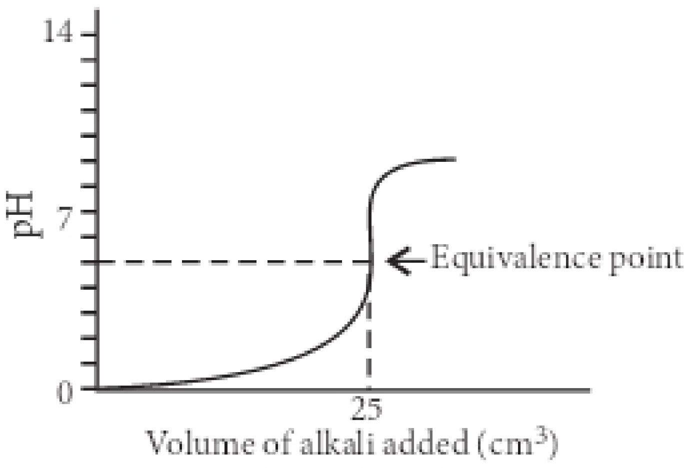
1. Which of the following does not give borax bead test?
(a) Cr^{3+} (b) Cu^{2+} (c) Mn^{2+} (d) Pb^{2+}

2. In the test of basic radicals, which reagent is used in IVth group?
(a) $H_2S + HCl$
(b) $NH_4OH + NH_4Cl$
(c) $NH_4OH + NH_4Cl + H_2S$ gas
(d) $NH_4OH + NH_4Cl + (NH_4)_2CO_3$

3. Which of the following groups constitute basic radicals of fourth group?
(a) $Pb^{2+}, Hg^{2+}, Cd^{2+}$ (b) $Zn^{2+}, Mn^{2+}, Ni^{2+}$
(c) $Al^{3+}, Fe^{3+}, Cr^{3+}$ (d) $Ca^{2+}, Sr^{2+}, Ba^{2+}$

4. Kjeldahl's method is used in the estimation of
(a) nitrogen (b) halogens
(c) sulphur (d) oxygen.

5. 10 mL of 1 M NaOH solution is neutralized by ...... mL of 1 M H_2SO_4 solution.
(a) 2.5 (b) 2.0 (c) 10 (d) 5

6. 

The given graph represents titration curve for
(a) strong acid with strong base
(b) weak acid with strong base
(c) strong acid with weak base
(d) weak acid with weak base.

7. Sodium extract of an organic compound is
(a) alkaline in nature (b) acidic in nature
(c) neutral
(d) depends on the nature of organic compound.

8. The change in pH near the end point will be maximum in the titration of
(a) HCl *vs* NaOH (b) CH_3COOH *vs* NaOH
(c) HCl *vs* NH_4OH
(d) CH_3COOH *vs* NH_4OH.

9. Which of the following compounds gives blood red colouration when its Lassaigne's extract is treated with alkali and ferric chloride?
(a) Thiourea (b) Benzaldehyde
(c) Phenyl hydrazine (d) Benzamide

10. During the determination of heat of solution of copper sulphate, salt is taken in powdered form because
(a) it decreases the surface area
(b) it increases the number of particles
(c) it facilitates the dissolution in minimum time
(d) it makes the process endothermic.

11. In which of the following acid-base titrations, pH is greater than 8 at the equivalence point?
(a) Acetic acid *vs* ammonia
(b) Acetic acid *vs* sodium hydroxide
(c) Hydrochloric acid *vs* ammonia
(d) Hydrochloric acid *vs* sodium hydroxide

12. The solution of a chemical compound reacts with $AgNO_3$ solution to form a white precipitate of *Y* which dissolves in NH_4OH to give a complex *Z*. When *Z* is treated with dilute HNO_3, *Y* reappears. The chemical compound *X* can be
(a) NaCl (b) CH_3Cl (c) NaBr (d) NaI

13. A white sodium salt dissolves readily in water to give a solution which is neutral to litmus. When silver nitrate solution is added to the solution, a white precipitate is obtained which does not dissolve in dilute HNO_3. The anion could be
(a) CO_3^{2-} (b) Cl^- (c) SO_4^{2-} (d) S^{2-}

14. In Carius method, 0.099 g organic compound gave 0.287 g AgCl. The percentage of chlorine in the compound will be
(a) 28.6 (b) 71.7 (c) 35.4 (d) 64.2

15. Chromatography is a valuable method for the separation, isolation, purification and identification of the constituents of a mixture and it is based on general principle of
(a) phase rule (b) phase distribution
(c) interphase separation
(d) phase operation.

16. In which of the following solvents, AgBr will have the highest solubility?
(a) 10^{-3} M NaBr (b) 10^{-3} M NH_4OH
(c) Pure water (d) 10^{-3} M HBr

17. In $KMnO_4$ titration in acidic medium, equivalent mass of $KMnO_4$ is
(a) *M* (b) *M*/5 (c) *M*/2 (d) *M*/3

18. Which of the following indicators should be used for titration of NH_4OH with HCl solution?
(a) Methyl orange (b) Phenolphthalein
(c) Thymol blue (d) Alizarin yellow

19. Dimethyl glyoxime gives a red ppt. with Ni^{2+} which is used for detection of nickel. To get this precipitate, the best pH range is
(a) < 1 (b) 2-3 (c) 3-4 (d) 9-11

20. Sulphur is converted into S^{2-} on fusion with sodium. Sulphide can be detected by
(a) $Pb(OAc)_2$ - black precipitate
(b) $Na_2[Fe(CN)_5NO]$ - yellow colour
(c) neutral $FeCl_3$
(d) all of these.

SOLUTIONS

1. **(d):** Pb^{2+} is not coloured and will not give borax bead test.

2. **(c):** IVth group reagent
$\Rightarrow (NH_4OH + NH_4Cl + H_2S \text{ gas})$

3. **(b):** Zn^{2+}, Mn^{2+}, Ni^{2+} and Co^{2+} are basic radicals of IV^{th} group.

4. **(a)**

5. **(d):** $N_1V_1 = N_2V_2$, $\therefore$ $10 \times 1 = V \times 2$, $\therefore$ $V = 5$ mL

6. **(c):** Since at equivalence point pH is less than 7 it must be the titration curve of strong acid with weak base.

7. **(a):** During sodium extract formation, excess of sodium reacts with water to give NaOH.

$$2Na + H_2O \rightarrow 2NaOH + H_2$$

8. **(a)**

9. **(a):** Thiourea contains both S and N and hence gives blood red colouration when its Lassigne's extract is treated with alkali and $FeCl_3$.

$$3NaCNS + FeCl_3 \longrightarrow \underset{\substack{\text{Ferric thiocyanate}\\ \text{(Blood red)}}}{Fe(CNS)_3} + 3NaCl$$

10. **(c)**

11. **(b)**

12. **(a):** $\underset{(X)}{NaCl} + AgNO_3 \longrightarrow \underset{\substack{(Y)\\ \text{(White)}}}{AgCl}$

$$\underset{(Y)}{AgCl} + 2NH_4OH \longrightarrow \underset{(Z)}{[Ag(NH_3)_2]Cl} + 2H_2O$$

$$\underset{(Z)}{[Ag(NH_3)_2]Cl} + HNO_3 \longrightarrow \underset{(Y)}{AgCl} + NH_4NO_3$$

CH_3Cl does not give ppt. NaBr and NaI give yellow and dark yellow ppt. respectively.

13. **(b):** $NaCl + AgNO_3 \longrightarrow \underset{\text{white ppt.}}{AgCl} + NaNO_3$

14. **(b):** % of chlorine

$$= \frac{35.5}{143.5} \times \frac{\text{Mass of AgCl}}{\text{Mass of substance}} \times 100$$

$$= \frac{35.5}{143.5} \times \frac{0.287}{0.099} \times 100 = 71.71\%$$

15. **(b)**

16. **(b)**

17. **(b):** In $KMnO_4$ titration, $KMnO_4$ is reduced as

$$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

$$\text{Eq. mass} = \frac{\text{Mol. mass}}{\text{No. of electrons gain or lost}} = \frac{M}{5}$$

18. **(a)**

19. **(d):** The preceipitation of $Ni(DMG)_2$ occurs completely in basic medium.

20. **(a):** $Pb(OAc)_2 + S^{2-} \rightarrow \underset{\substack{\text{Lead sulphide}\\ \text{(Black ppt.)}}}{PbS\downarrow} + 2AcO^-$

◈◈

What is the debate around RO water?

What are reverse osmosis (RO) systems?

RO was originally a technology devised to desalinate sea water. The idea exploits the principle of osmosis. Take a tube, twist it into a 'U'-shape and insert a semi-permeable membrane (a material with very small holes that will allow only certain molecules to filter through) at the point where the tube curves. Fill half the tube with salt water and the other with fresh water. Over time, fresh water will cross over into the salty arm until the proportion of salt and water in both arms is the same. This is due to osmotic pressure which dilutes a region with a higher concentration of solute (in this case, the salt).

Say you wanted to readjust this tube and have all the salt in one arm and pure water in the other. You would need to create some external pressure that will counter the osmotic pressure and suck all the water from the salty arm into the fresh water arm while leaving the salt behind. This is the essential principle of an RO system.

RO desalination came about in the late 1950s and primarily in large industrial settings to convert brackish sea water into potable drinking water.

However, it is possible to deploy a wide array of membranes and multiple stages of filters to filter a wide variety of solutes — arsenic, fluoride, hexavalent chromium, nitrates, bacteria — that come mixed in water. This has led to an industry of home-RO systems that are installed in a multiplicity of ways to provide potable water.

To create external pressure, RO relies on a pump and electric motors. It uses "activated carbon" components, such as charcoal and carbon black that can filter out contaminants as well as organic substances such as bacteria. It all depends on the filtering material and the number of filters that incoming tap water must pass through.

What is the problem with RO?

"One concern with RO is that it filters essential salts needed by the body. However, many manufacturers claim to overcome this challenge by 'post-treatment'

In making tap water pass through multiple stages of cleaning, RO systems end up wasting a lot of water. Anywhere between three-five times more water is wasted by them than they produce and given the challenges that cities and government face in providing potable water, environmentalist groups have convinced the National Green Tribunal to ban the use of RO systems in Delhi. It is as part of this legal dispute, which began in March 2019 that led the Environment Ministry to move to regulate RO systems.

Another concern with RO is that it filters out calcium, zinc, magnesium, which are essential salts needed by the body; drinking such water over time could be harmful. However, many manufacturers claim to overcome this challenge by "post-treatment". The average RO system only aims to reduce Total Dissolved Solids, ensure water is odourless and has a pH from 6.5-8.5. The National Institute of Virology (NIV) claimed that most filtration methods did not eliminate Hepatitis E virus. A combination of filtration systems can eliminate most contaminants.

But opponents of RO systems say this increases costs and reduces the incentive for public-funded water distribution systems to supply clean water to the vast majority of the country who can ill-afford such systems.

Courtesy : The Hindu

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MONTHLY TEST DRIVE

XI

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

Equilibrium | Redox Reactions

Time Taken : 60 Min.

NEET

Only One Option Correct Type

1. In $[Cr(O_2)(NH_3)_4H_2O]Cl_2$, oxidation number of Cr is +3, then oxygen will be in the form of
(a) dioxo (b) peroxo (c) superoxo (d) oxo.

2. Consider the reaction, $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ where $K_p = 0.497$ at 500 K. If three gases are mixed in a rigid container so that the partial pressure of each gas is initially 1 atm, then which of the following statements is true?
(a) More PCl_5 will be produced.
(b) More PCl_3 will be produced.
(c) Equilibrium will be established when 50% reaction is complete.
(d) None of the above.

3. In the reaction of sodium thiosulphate with I_2 in aqueous medium the equivalent weight of sodium thiosulphate is equal to
(a) molar mass of sodium thiosulphate
(b) the average molar mass of $Na_2S_2O_3$ and I_2
(c) half the molar mass of sodium thiosulphate
(d) twice of molar mass of sodium thiosulphate.

4. Ammonium cyanide is a salt of NH_4OH ($K_b = 1.8 \times 10^{-5}$) and HCN ($K_a = 4.0 \times 10^{-10}$). The hydrolysis constant of 0.1 M NH_4CN at 25°C is
(a) 1.4 (b) 7.2 (c) 7.2 (d) 1.4

5. 20 g sample of H_2O_2 is oxidised by 46.9 mL of 0.145 M $KMnO_4$ according to the following reaction :
$2MnO_4^- + 5H_2O_2 + 6H^+ \longrightarrow 2Mn^{2+} + 5O_2 + 8H_2O$
The mass % of H_2O_2 in the sample is
(a) 2.89 (b) 3.90 (c) 1.95 (d) 4.93

6. 20 cm^3 of xM solution of HCl is exactly neutralised by 40 cm^3 of 0.05 M NaOH solution, the pH of HCl solution is
(a) 1.0 (b) 2 (c) 1.5 (d) 2.5

7. Which of the following observations is correct when dilute H_2SO_4 is added in a mixture containing SO_3^{2-} and S^{2-}?
(a) SO_2 and H_2S are not formed.
(b) SO_2 and H_2S are formed during change undergoes a redox change forming colloidal sulphur and thus, no smell is observed.
(c) A smell of burning sulphur appeared.
(d) A smell of rotten egg appeared.

8. The hydrolysis constant K_H for the reaction,
$H_2PO_4^- + H_2O \longrightarrow H_3PO_4 + OH^-$ is 1.4×10^{-12}.
The ionisation constant for
$H_3PO_4 + H_2O \longrightarrow H_2PO_4^- + H_3O^+$ is
(a) 7.14×10^{-3} (b) 1.14×10^{-12}
(c) 7.14×10^{-12} (d) 1.4×10^{-3}

9. The anion nitrate is converted into ammonium ion. The equivalent mass of nitrate ion in the reaction would be
(a) 6.20 (b) 7.75 (c) 10.5 (d) 21.0

10. The pK_b for fluoride ion at 25 °C is 10.83. The ionization constant of hydrofluoric acid at this temperature is
(a) 1.74×10^{-5} (b) 3.52×10^{-3}
(c) 6.75×10^{-4} (d) 5.38×10^{-2}

11. Consider the following reaction,
$P_4 + 3NaOH + 3H_2O \longrightarrow 3NaH_2PO_2 + PH_3$
In the above reaction,
1. Phosphorus is oxidised.
2. Phosphorus is reduced.
Which of the above statements is/are correct?
(a) Only 1 (b) Only 2
(c) Both 1 and 2 (d) Neither 1 nor 2

12. The concentration of $[H^+]$ and concentration of $[OH^-]$ of a 0.1 m aqueous solution of 2% ionised weak acid is respectively
[Ionic product of water $= 1 \times 10^{-14}$]
(a) 0.02×10^{-3} M and 5×10^{-11} M
(b) 1×10^{-3} M and 3×10^{-11} M
(c) 2×10^{-3} M and 5×10^{-12} M
(d) 3×10^{-2} M and 4×10^{-13} M.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** Nitric acid (HNO_3) acts as an oxidising agent while nitrous acid (HNO_2) acts both as oxidising and reducing agent.
Reason : Oxidation state of nitrogen in HNO_3 is –5 while in HNO_2, it is +5.

14. **Assertion :** A catalyst does not influence the values of equilibrium constant.
Reason : Catalyst influences the rate of both forward and backward reactions equally.

15. **Assertion :** Greater the value of K, more is the fraction of initial concentration of reactants converted to products at equilibrium.
Reason : The value of K depends on the initial concentration of reactants.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. For the reaction,
$$M^{x+} + MnO_4^- \longrightarrow MO_3^- + Mn^{2+} + 1/2O_2$$
if one mole of MnO_4^- oxidises 1.67 moles of M^{x+} to MO_3^-, then the value of x in the reaction is
(a) 5 (b) 3 (c) 2 (d) 1

17. Acetic acid and propionic acid have K_a values 1.75×10^{-5} and 1.3×10^{-5} respectively at a certain temperature. An equimolar solution of a mixture of the two acids is partially neutralised by NaOH. How is the ratio of the contents of acetate and propionate ions related to each other, if α and β are ionised fractions of the acids?
(a) $\left(\dfrac{\alpha}{1-\alpha}\right) = \dfrac{1.75}{1.3} \times \left(\dfrac{\beta}{1-\beta}\right)$
(b) $\dfrac{1-\alpha}{\alpha} = \dfrac{1.75}{1.3} \times \left(\dfrac{\beta}{1-\beta}\right)$
(c) $\alpha = \dfrac{1.3}{1.75} \times \left(\dfrac{1-\beta}{\beta}\right)$ (d) $\alpha = \dfrac{1.3}{1.75} \times (1-\beta)$

18. A solution of 10 mL $M/10$ $FeSO_4$ was titrated with $KMnO_4$ solution in acidic medium. The amount of $KMnO_4$ used will be
(a) 5 mL of 0.1 M (b) 10 mL of 0.1 M
(c) 10 mL of 0.5 M (d) 10 mL of 0.02 M.

19. The correct relationship between pH of isomolar solution of sodium oxide (pH_1), sodium sulphide (pH_2), sodium selenide (pH_3) and sodium telluride (pH_4) is
(a) $pH_1 > pH_2 > pH_3 > pH_4$
(b) $pH_1 < pH_2 \simeq pH_3 < pH_4$
(c) $pH_1 < pH_2 < pH_3 < pH_4$
(d) $pH_1 > pH_2 \simeq pH_3 > pH_4$

More than One Options Correct Type

20. Which of the following statements are correct?
(a) The pH of 1.0×10^{-8} M solution of HCl is 8.
(b) The conjugate base of $H_2PO_4^-$ is HPO_4^{2-}.
(c) Autoprotolysis constant of water increases with temperature.
(d) When a solution of a weak monoprotic acid is titrated against a strong base, at half-neutralisation point $pH = (1/2)\,pK_a$.

21. Identify the incorrect statements.
(a) Oxidation state of sulphur in SCN^- is –1.
(b) 1 mol of $K_4[Fe(CN)_6]$ contains 5 mol of ions in aqueous medium.
(c) Hydrochloric acid oxidises Fe to Fe^{3+}.
(d) Sulphur dioxide is a more powerful oxidising agent in alkaline medium than in acidic medium.

22. Which of the following are true for the reaction, $A_2 \rightleftharpoons 2C + D$?
(a) If $\Delta H = 0$; K_p increases with temperature at dissociation temperature.
(b) If $\Delta H = +ve$, K_p increases with temperature and dissociation of A_2 increases.
(c) If $\Delta H = -ve$; K_p decreases with temperature and dissociation of A_2 decreases.
(d) $K_p = 4\alpha^3\left[\dfrac{P}{1+2\alpha}\right]^2$

23. Which of the following statements are correct regarding given equations?
(i) $Pb_3O_4 + 8HCl \longrightarrow 3PbCl_2 + Cl_2 + 4H_2O$
(ii) $Pb_3O_4 + 4HNO_3 \longrightarrow Pb(NO_3)_2 + PbO_2 + 2H_2O$
(a) Pb_3O_4 is a mixed oxide having bases PbO and PbO_2 in 2 : 1 ratio.
(b) Reaction (i) is acid-base reaction of PbO and HCl along with redox change between PbO_2 and HCl.

(c) Reaction (ii) is simply acid-base reaction between PbO and HNO_3.
(d) PbO_2 does not show redox change with HNO_3.

Numerical Value Type

24. One mole of ethanol is treated with one mole of ethanoic acid at 25°C. Half of the acid changes into ester at equilibrium. The equilibrium constant for the reaction is

25. The number of species that will have coefficient of '2' in the following equation after balancing is (Balanced equation must contain least integral multiples.)

$$[CrSCN]^{2+} + BrO^- + OH^- \longrightarrow Br^- + NO_3^- + CO_3^{2-} + SO_4^{2-} + CrO_4^{2-} + H_2O$$

26. 1 g impure sample of P_4O_6 is treated with 20 mL '*a*' M $KMnO_4$ in acidic medium to produce H_3PO_4 and $MnCl_2$. 20 mL of same $KMnO_4$ requires 10 mL of 0.2M $FeSO_4$ for complete reduction. The % purity of P_4O_6 is

Matrix Match Type

Answer the following questions (27 and 28) by appropriately matching the columns based on the information given in the passage :

Concept of number of equivalents is very useful in the stoichiometric calculation of reactions. Number of equivalents of all the participating species are equal in a reaction.

$$\text{Equivalent mass} = \frac{\text{Molecular mass (or atomic mass)}}{n\text{-factor}} = \frac{M}{n}$$

n-factor of a reactant is the number of moles of electrons lost or gained per mole of reactant involved in a redox reaction *e.g.*,

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O\ ; \quad n = 5$$
$$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O\ ; \quad n = 6$$

	Column-I (Redox process)		Column-II (*n*-factor for underlined species)
P.	$\underline{As_2S_3} \rightarrow AsO_3^- + SO_4^{2-}$	I.	28
Q.	$\underline{I_2} \rightarrow I^- + IO_3^-$	II.	4/3
R.	$\underline{H_3PO_2} \rightarrow PH_3 + 2H_3PO_3$	III.	1
S.	$\underline{H_3PO_2} + NaOH \rightarrow NaH_2PO_2 + H_2O$	IV.	5/3

27. Which of the following has the correct combination considering column-I and column-II?
(a) P → III (b) Q → IV (c) R → I (d) S → II

28. Which of the following has the correct combination considering column-I and column-II?
(a) P → I (b) Q → II (c) R → III (d) S → IV

Answer the following questions (29 and 30) by appropriately matching the columns based on the information given in the passage :

Physical and chemical equilibrium can respond to a change in their pressure, temperature, and concentration of reactants and products. To describe the change in the equilibrium we have a principle named Le Chatelier's principle. According to this principle, even if we make some changes in equilibrium, then also the system even re-establishes the equilibrium by undoing the effect.

	Column-I		Column-II
P.	$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$; $\Delta H = +180.0$ kJ	I.	Increases with increase in temperature
Q.	$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$; $\Delta H = +57.0$ kJ	II.	Decreases with increase in pressure
R.	$4NH_{3(g)} + 5O_{2(g)} \rightleftharpoons 4NO_{(g)} + 6H_2O_{(g)}$; $\Delta H = -900.0$ kJ	III.	Increases with addition of inert gas at constant pressure
S.	$NO_{(g)} + O_{3(g)} \rightleftharpoons NO_{2(g)} + O_{2(g)}$; $\Delta H = -200$ kJ	IV.	Decreases with increase in temperature

29. Which of the following has the correct combination considering column-I and column-II?
(a) P → I, III (b) Q → I, IV
(c) R → II, III, IV (d) S → II, IV

30. Which of the following has the correct combination considering column-I and column-II?
(a) P → II, III (b) Q → II
(c) R → I, III (d) S → IV

Keys are published in this issue. Search now! ☺

CHECK YOUR PERFORMANCE

No. of questions attempted ......
No. of questions correct ......
Marks scored in percentage ......

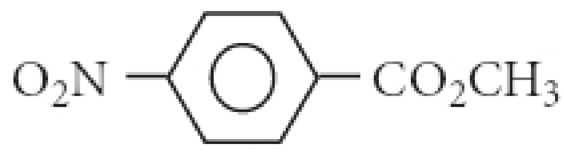
If your score is

> 80%	Your preparation is going good, keep it up to get high score.
60-80%	Need more practice, try hard to score more next time.
<60%	Stress more on concepts and revise thoroughly.

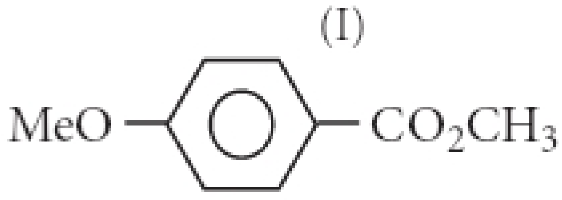
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CATEGORY-I

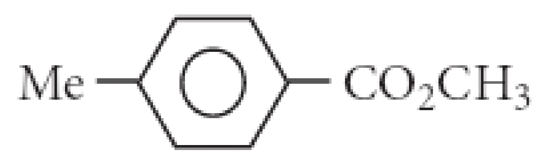
Single Correct Answers

1. 

(I)



(II)



(III)

For the above three esters, the order of rates of alkaline hydrolysis is

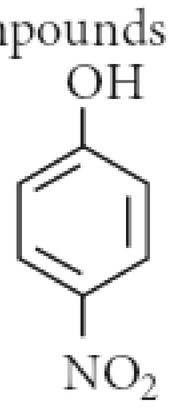
(a) I > II > III (b) II > III > I
(c) I > III > II (d) III > I > II

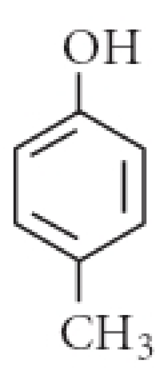
2. $Ph-CDO \xrightarrow[\text{Warm}]{50\% \text{ aq. NaOH}} Ph-COOH + \text{an alcohol}$

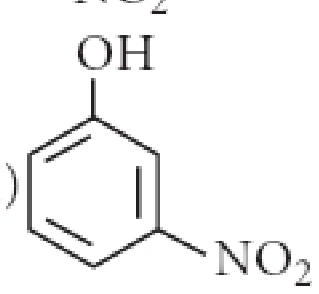
This alcohol is

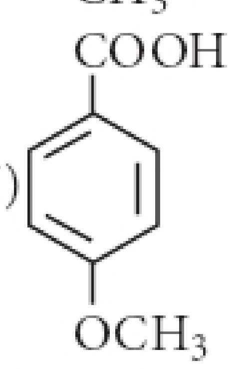
(a) $Ph-CHD-OH$ (b) $Ph-CHD-OD$
(c) $Ph-CD_2-OH$ (d) $Ph-CD_2-OD$

3. The correct order of acidity for the following compounds is

(I) 

(II) 

(III) 

(IV) 

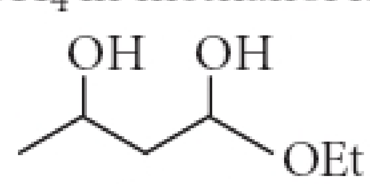
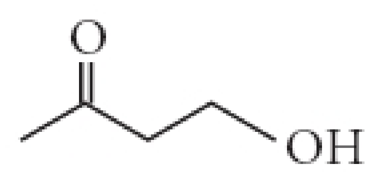
(a) II < IV < III < I (b) II < III < I < IV
(c) II < III < IV < I (d) III < II < I < IV

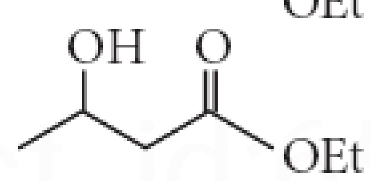
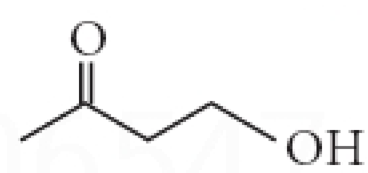
4. For the following carbocations, the correct order of stability is

(I) $\overset{+}{C}H_2-COCH_3$ (II) $\overset{+}{C}H_2-OCH_3$
(III) $\overset{+}{C}H_2-CH_3$

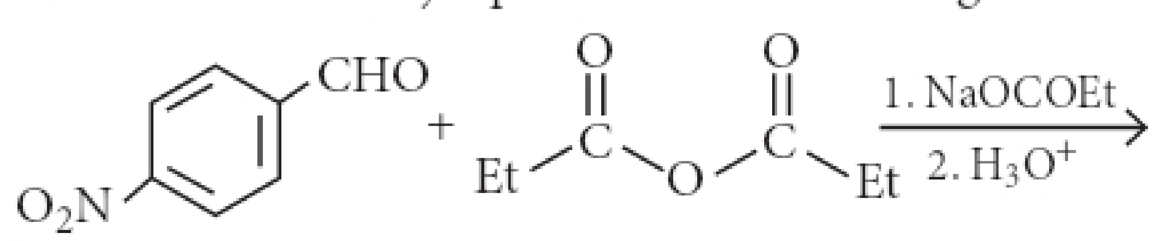
(a) III < II < I (b) II < I < III
(c) I < II < III (d) I < III < II

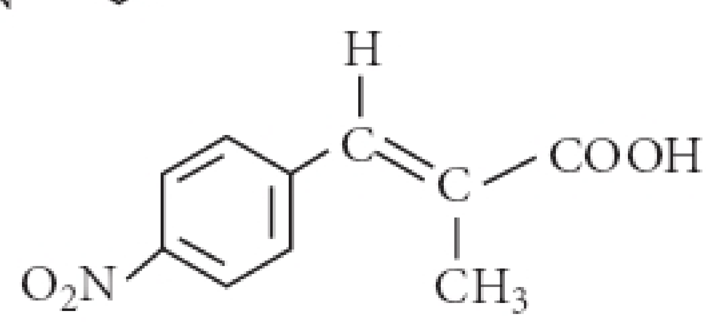
5. The reduction product of ethyl 3-oxobutanoate by $NaBH_4$ in methanol is

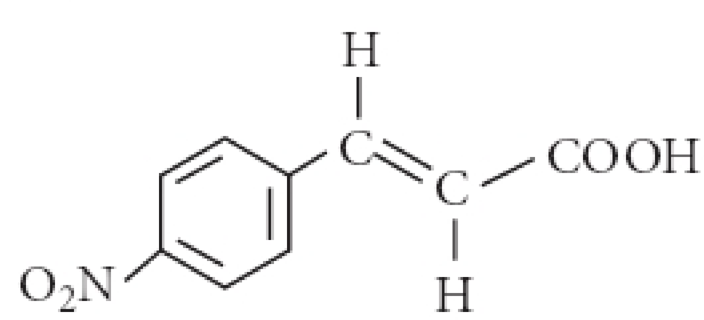
(a)  (b) 

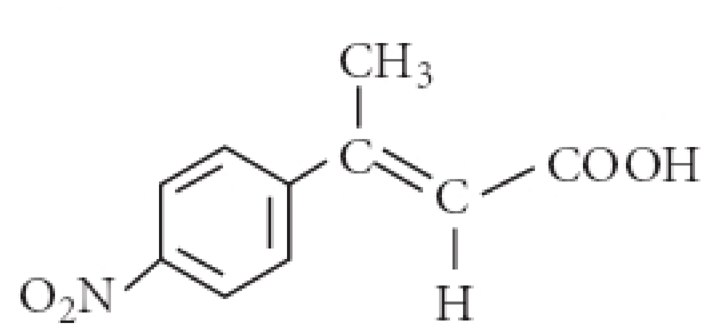
(c)  (d) 

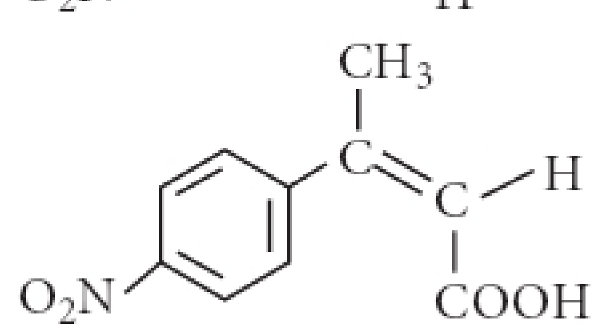
6. What is the major product of the following reaction?



(a) 

(b) 

(c) 

(d) 

7. The maximum number of electrons in an atom in which the last electron filled has the quantum numbers $n = 3$, $l = 2$ and $m = -1$ is
(a) 17 (b) 27 (c) 28 (d) 30

8. In the face-centred cubic lattice structure of gold the closest distance between gold atoms is ('a' being the edge length of the cubic unit cell)
(a) $a\sqrt{2}$ (b) $\frac{a}{\sqrt{2}}$ (c) $\frac{a}{2\sqrt{2}}$ (d) $2\sqrt{2}a$

9. The equilibrium constant for the following reactions are given at 25 °C
$2A \rightleftharpoons B + C,\ K_1 = 1.0$
$2B \rightleftharpoons C + D,\ K_2 = 16$
$2C + D \rightleftharpoons 2P,\ K_3 = 25$
The equilibrium constant for the reaction, $P \rightleftharpoons A + \frac{1}{2}B$ at 25 °C is
(a) $\frac{1}{20}$ (b) 20 (c) $\frac{1}{42}$ (d) 21

10. Among the following the ion which will be more effective for flocculation of $Fe(OH)_3$ sol is
(a) PO_4^{3-} (b) SO_4^{2-} (c) SO_3^{2-} (d) NO_3^-

11. The mole fraction of ethanol in water is 0.08. Its molality is
(a) 6.32 mol kg^{-1} (b) 4.83 mol kg^{-1}
(c) 3.82 mol kg^{-1} (d) 2.84 mol kg^{-1}.

12. 5 mL of 0.1 M $Pb(NO_3)_2$ is mixed with 10 mL of 0.02 M KI. The amount of PbI_2 precipitated will be
(a) 10^{-2} mol (b) 10^{-4} mol
(c) 2×10^{-4} mol (d) 10^{-3} mol.

13. At 273 K temperature and 76 cm Hg pressure, the density of a gas is 1.964 g L^{-1}. The gas is
(a) CH_4 (b) CO (c) He (d) CO_2.

14. Equal masses of ethane and hydrogen are mixed in an empty container at 298 K. The fraction of total pressure exerted by hydrogen is
(a) 15 : 16 (b) 1 : 1 (c) 1 : 4 (d) 1 : 6

15. An ideal gas expands adiabatically against vacuum. Which of the following is correct for the given process?
(a) $\Delta S = 0$ (b) $\Delta T = -ve$
(c) $\Delta U = 0$ (d) $\Delta P = 0$

16. K_f (water) = 1.86 K kg mol^{-1}. The temperature at which ice begins to separate from a mixture of 10 mass % ethylene glycol is
(a) −1.86 °C (b) −3.72 °C
(c) −3.33 °C (d) −3 °C

17. The radius of the first Bohr orbit of a hydrogen atom is 0.53×10^{-8} cm. The velocity of the electron in the first Bohr orbit is
(a) 2.188×10^8 cm s^{-1} (b) 4.376×10^8 cm s^{-1}
(c) 1.094×10^8 cm s^{-1} (d) 2.188×10^9 cm s^{-1}

18. Which of the following statements is not true for the reaction,
$$2F_2 + 2H_2O \longrightarrow 4HF + O_2?$$
(a) F_2 is more strongly oxidising than O_2.
(b) F — F bond is weaker than O = O bond.
(c) H — F bond is stronger than H — O bond
(d) F is less electronegative than O.

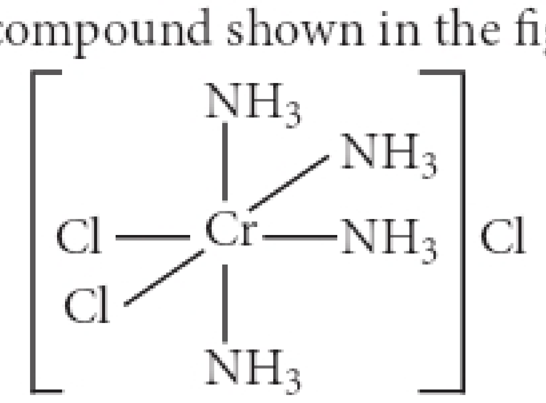
19. The number of unpaired electrons in the uranium ($_{92}U$) atom is
(a) 4 (b) 6 (c) 3 (d) 1

20. How and why does the density of liquid water change on prolonged electrolysis?
(a) Decreases, as the proportion of H_2O increases
(b) Remains unchanged
(c) Increases, as the proportion of D_2O increases
(d) Increases, as the volume decreases

21. The difference between orbital angular momentum of an electron in a 4f orbital and another electron in a 4s orbital is
(a) $2\sqrt{3}$ (b) $3\sqrt{2}$ (c) $\sqrt{3}$ (d) 2

22. Which of the following has the largest number of atoms?
(a) 1 g of Ag (b) 1 g of Fe
(c) 1 g of Cl_2 (d) 1 g of Mg

23. Indicate the correct IUPAC name of the coordination compound shown in the figure.



(a) *Cis*-dichlorotetraminochromium(III) chloride
(b) *Trans*-dichlorotetraminochromium(III) chloride
(c) *Trans*-tetraminedichlorochromium(III) chloride
(d) *Cis*-tetraminedichlorochromium(III) chloride

24. What will be the mass of one atom of ^{12}C?
(a) 1 a.m.u (b) 1.9923×10^{-23} g
(c) 1.6603×10^{-22} g (d) 6 a.m.u

25. Bond order of He_2, He_2^+ and He_2^{2+} are respectively
(a) $1, \frac{1}{2}, 0$ (b) $0, \frac{1}{2}, 1$ (c) $\frac{1}{2}, 1, 0$ (d) $1, 0, \frac{1}{2}$

26. To a solution of a colourless efflorescent sodium salt, when dilute acid is added, a colourless gas is evolved along with formation of a white precipitate. Acidified dichromate solution turns green when the colourless gas is passed through it. The sodium salt is
(a) Na_2SO_3 (b) Na_2S
(c) $Na_2S_2O_3$ (d) $Na_2S_4O_6$

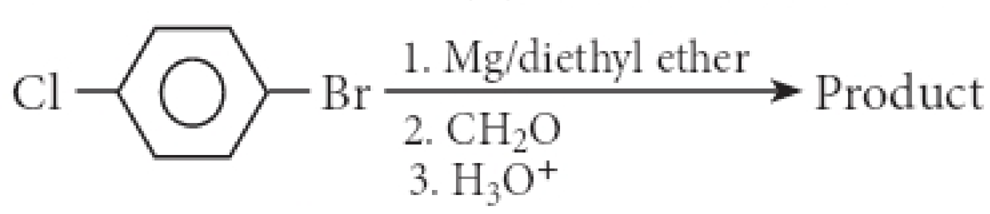
27. The reaction for obtaining the metal (M) from its oxide (M_2O_3) ore is given by

$$M_2O_{3(s)} + 2Al_{(l)} \xrightarrow{\text{Heat}} Al_2O_{3(l)} + 2M_{(s)}$$

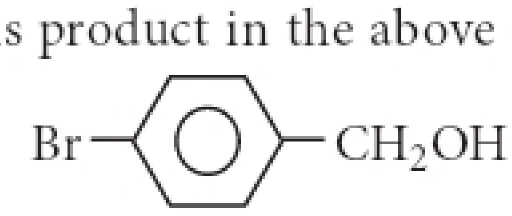
(s-solid, l-liquid)
in that case, M is
(a) copper (b) calcium
(c) iron (d) zinc.

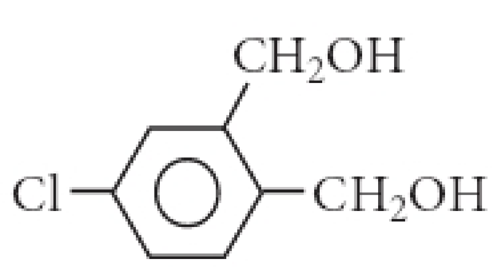
28. In the extraction of Ca by electro-reduction of molten $CaCl_2$ some CaF_2 is added to the electrolyte for the following reason :
(a) To keep the electrolyte in liquid state at temperature lower than the m.p. of $CaCl_2$
(b) To effect precipitation of Ca
(c) To effect the electrolysis at lower voltage
(d) To increase the current efficiency.

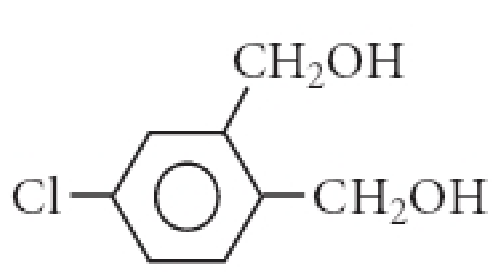
29. The total number of alkyl bromides (including stereoisomers) formed in the reaction
$Me_3C-CH=CH_2 + HBr \longrightarrow$
will be
(a) 1 (b) 2
(c) 3 (d) no bromide forms.

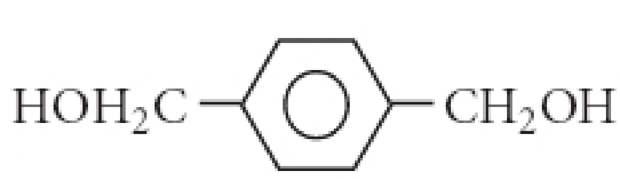
30. 

This product in the above reaction is

(a) 

(b) 

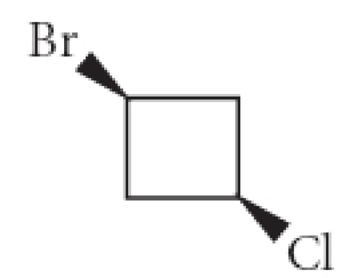
(c) 

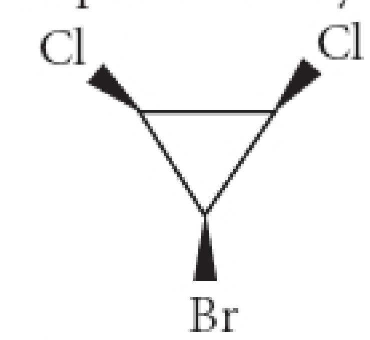
(d) 

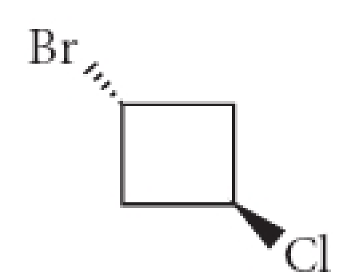
CATEGORY-II

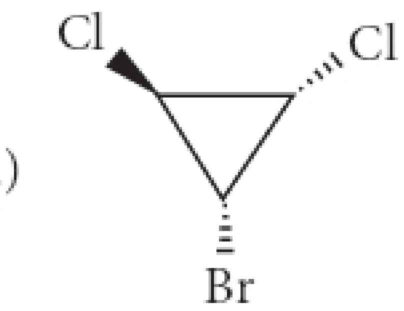
Single Correct Answers

31. Which of the following compounds is asymmetric?

(a) 

(b) 

(c) 

(d) 

32. For a reaction $2A + B \longrightarrow P$, when concentration of B alone is doubled $t_{1/2}$ does not change and when concentrations of both A and B is doubled, rate increases by a factor of 4. The unit of rate constant is
(a) s^{-1} (b) $L\ mol^{-1}\ s^{-1}$
(c) $mol\ L^{-1}\ s^{-1}$ (d) $L^2\ mol^{-2}\ s^{-1}$

33. A solution is saturated with $SrCO_3$ and SrF_2. The $[CO_3^{2-}]$ is found to be 1.2×10^{-3} M. The concentration of F^- in the solution would be
(a) 3.7×10^{-6} M (b) 3.2×10^{-3} M
(c) 5.1×10^{-7} M (d) 3.7×10^{-2} M
Given : $K_{sp}(SrCO_3) = 7.0 \times 10^{-10}$, $K_{sp}(SrF_2) = 7.9 \times 10^{-10}$

34. A homonuclear diatomic gas molecule shows 2-electron magnetic moment. The one-electron and two-electron reduced species obtained from above gas molecule can act as both oxidizing and reducing agents. When the gas molecule is one-electron oxidized the bond length decreases compared to the neutral molecule. The gas molecule is
(a) N_2 (b) Cl_2 (c) O_2 (d) B_2

35. $CH_3-O-CH_2-Cl \xrightarrow[\Delta]{aq.\ OH^-} CH_3-O-CH_2-OH$

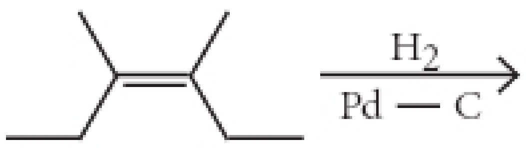
Which information below regarding this reaction is applicable?
(a) It follows S_N2 pathway, because it is a primary alkyl chloride.
(b) It follows S_N1 pathway, because the intermediate carbocation is resonance stabilized.
(c) S_N1 pathway is not followed, because the intermediate carbocation is destabilised by–I effect of oxygen.
(d) A mixed S_N1 and S_N2 pathway is followed.

CATEGORY-III

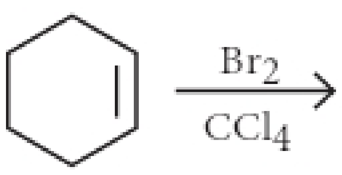
One or More Than One Correct Answers

36. Which of the following reactions give(s) a meso-compound as the main product?

(a) 

(b) 

(c) 

(d) 

37. For spontaneous polymerization, which of the following is (are) correct?

(a) ΔG is negative. (b) ΔH is negative.
(c) ΔS is positive. (d) ΔS is negative.

38. Which of the following statements is/are incorrect?

(a) A sink of SO_2 pollutant is O_3 in the atmosphere.
(b) FGD is a process of removing NO_2 from atmosphere.
(c) NO_x in fuel gases can be removed by alkaline scrubbing.
(d) The catalyst used to convert CCl_4 to CF_4 by HF is SbF_5

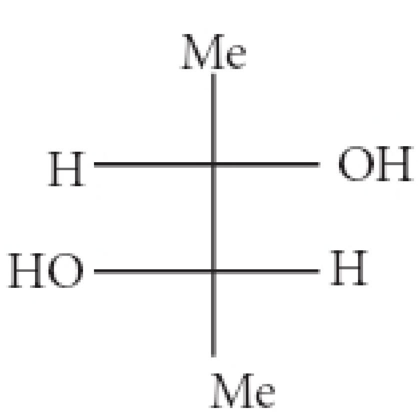
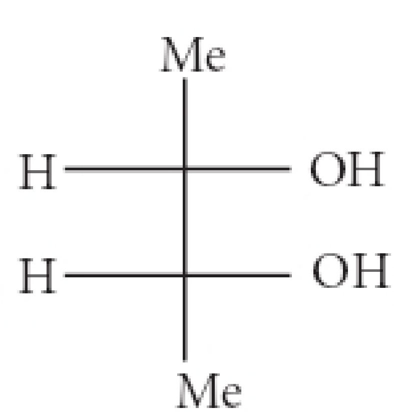
39. SiO_2 is attacked by which one/ones of the following?

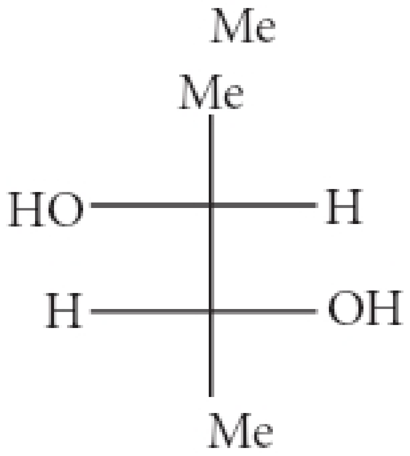
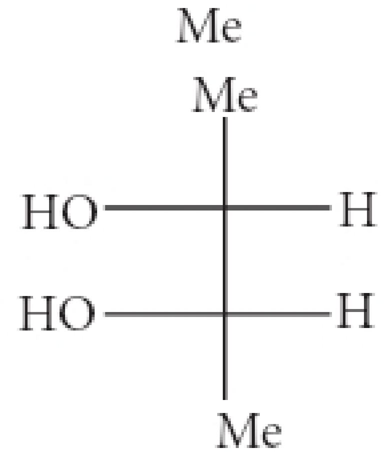
(a) HF (b) conc.HCl
(c) Hot NaOH (d) Fluorine

40. $\text{Me}-\text{C}\equiv\text{C}-\text{Me} \xrightarrow[\text{EtOH-33°C}]{\text{Na/NH}_3\text{(liq.)}}$

$$X \xrightarrow{\text{dil.alkaline KMnO}_4} \text{Product(s)}$$

The product(s) from above reaction will be

(a)  (b) 

(c)  (d) 

ANSWER KEYS

1. (c)	2. (c)	3. (b)	4. (d)	5. (c)
6. (a)	7. (b)	8. (b)	9. (a)	10. (a)
11. (b)	12. (b)	13. (d)	14. (a)	15. (c)
16. (c)	17. (a)	18. (d)	19. (a)	20. (c)
21. (a)	22. (d)	23. (d)	24. (b)	25. (b)
26. (a)	27. (c)	28. (a)	29. (c)	30. (d)
31. (d)	32. (b)	33. (d)	34. (c)	35. (d)
36. (a,b)	37. (a,b,d)	38. (a,b,d)	39. (a,c,d)	40. (a,c)

(For detail solutions, Refer to MTG WB JEE Chapterwise Explorer.)

For the SCIENTIST in YOU

New ways to convert petroleum waste into useful compounds by chemical reaction that uses a surprising molecule.

For more than a decade in the middle of the 20th century, chemists debated exactly what "carbocation", molecules with a positively charged carbon atom looked like. What is known as the "classical view," which was taught at the beginning of that century, stated that the carbon in these molecules held the charge; the "non-classical view" state that the charge could also be shared by other nearby atoms. Both theory and experiment eventually proved that non-classical carbocations existed, and the debate faded away.

Researchers have discovered a chemical reaction that might be used to process petroleum into useful compounds in which non-classical carbocations play key role. The findings also offer a new reaction to process alkanes, chemicals found in methane and propane gases that are notoriously hard to convert to other products.

There goal is to take smokestack garbage from a refinery and turn it into pharmaceuticals. Alkanes from this type of waste have posed a particular problem because they're chemically stable. That means it's difficult to break apart the bonds that hold these molecules together. A chemical reaction was discovered that seemed to be effectively alter alkanes into a byproduct that's more chemically useful.

When the researchers further analyzed the reaction with modern computational methods, they found that this reaction involves formation of a non-classical carbocation.

Since the charge is shared among multiple atoms (non-classical model) the molecule has more flexibility to undergo a diverse array of reactions, including those needed to break apart the strong bonds of alkanes. Only by looking at the reactions with molecular dynamics, following the motions of atoms as reactions occur, could the reactions be understood. For now, the alkanes aren't converted directly into drugs, but rather into other chemicals that might be useful in processing drug molecules. This reaction also has utility in breaking apart the long alkane molecules found in some non-biodegradable plastics.



CONCEPT BOOSTER

Hello students!!! Hope you all are doing well. As your friend I want to suggest you that this time-be completely focused on your studies and more precisely on your practice. Obviate unnecessary distractions. Occlude non-productive discussions and every day try to be better and better. In this acticle, I have presented 13 Questions which are important as well as concept based. Ideal time to solve this paper is 25 minutes. Hope you will like it.

*Arunava Sarkar

SINGLE OPTION CORRECT

1. For an orbital,

$$\psi_{300} = \frac{1}{81\sqrt{3\pi}} \cdot \left(\frac{Z}{a_0}\right)^{3/2} [27 - 18u + 2u^2] \exp\left(-\frac{4}{3}\right)$$

where, $u = \frac{Zr}{a_0}$.

What is the maximum radial distance of node from nucleus of He^+ ion?

(a) $(3+\sqrt{3})\frac{3a_0}{2}$ (b) $(3+\sqrt{3})\frac{3a_0}{4}$

(c) a_0 (d) $\frac{a_0}{2}$

2. What is the maximum degeneracy of a level of H-atom, where e^- has energy, $E_n = -\frac{Rhc}{9}$?

(a) 1 (b) 3

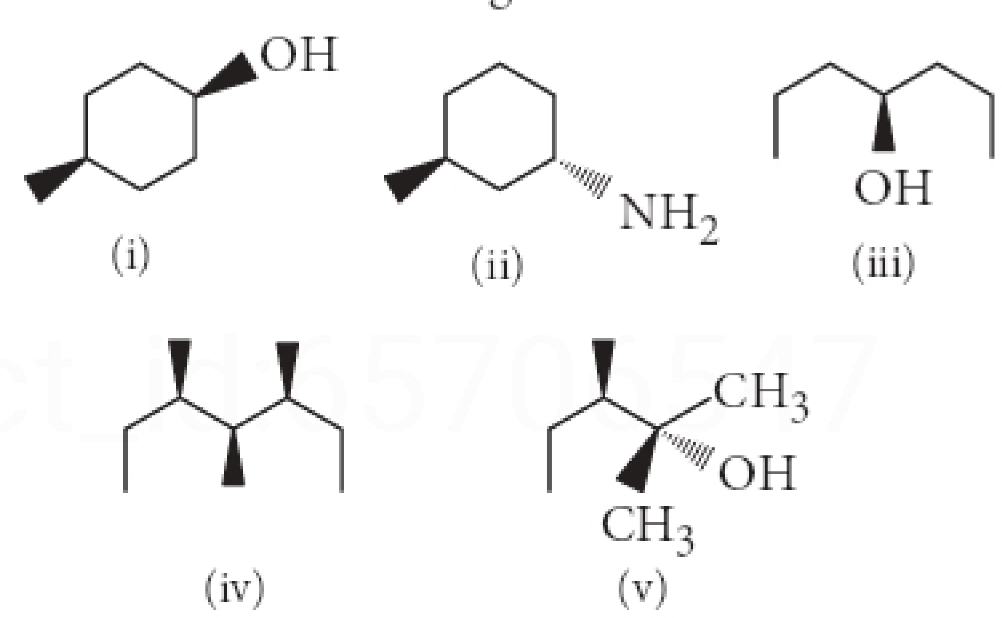
(c) 5 (d) 9

3. What fraction of oxygen molecules is $\left(\frac{dN}{N}\right)$ in the range of U_{mps} to $U_{mps} + fU_{mps}$ (where $f << 1$)?

(a) $\frac{4f}{e\sqrt{\pi}}$ (b) $\frac{4}{\sqrt{\pi}}\left(\frac{M}{2RT}\right)^{1/2} e^{-1}$

(c) $\frac{f}{e\pi}$ (d) 1

4. Which of the following is/are chiral molecules?

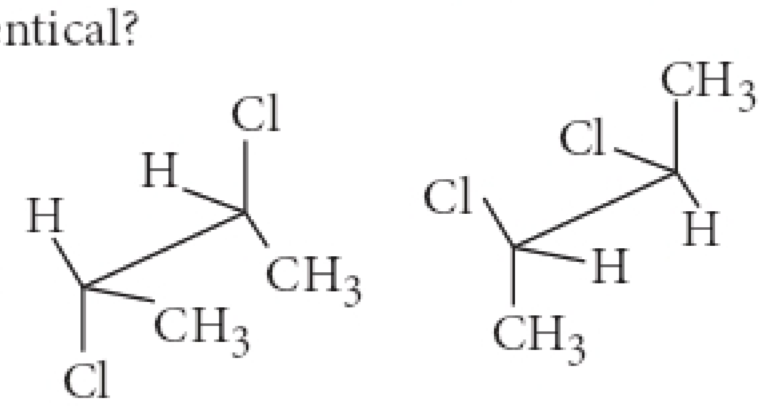


(a) (ii) (b) (i), (ii), (iv)

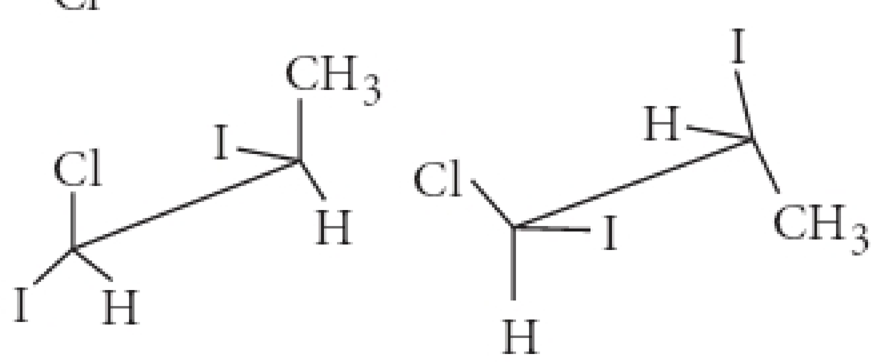
(c) (ii), (v) (d) (ii), (iv), (v)

5. Which of the following pairs of compounds is identical?

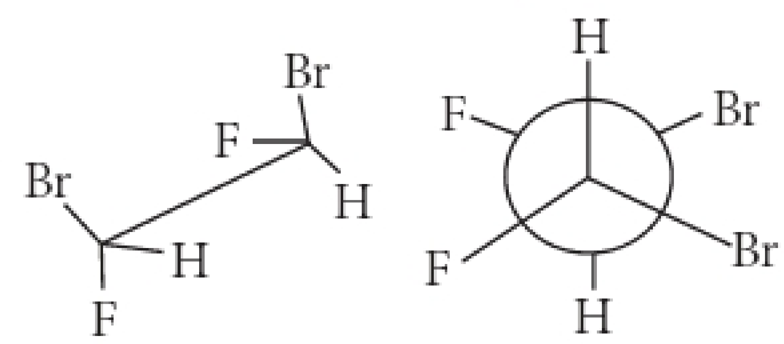
(a)

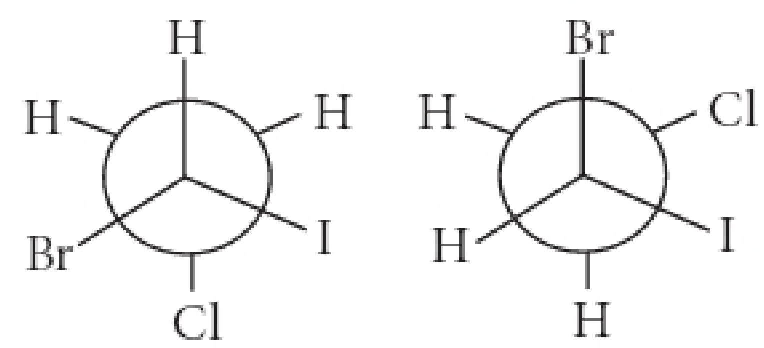


(b)



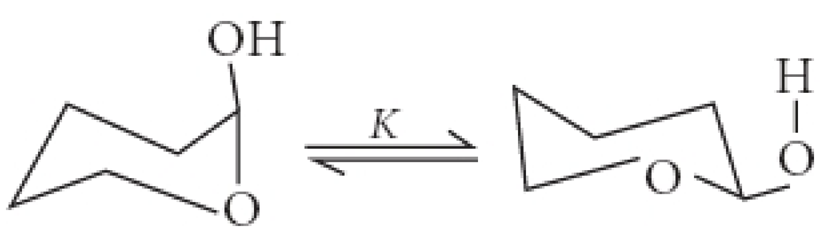
(c)

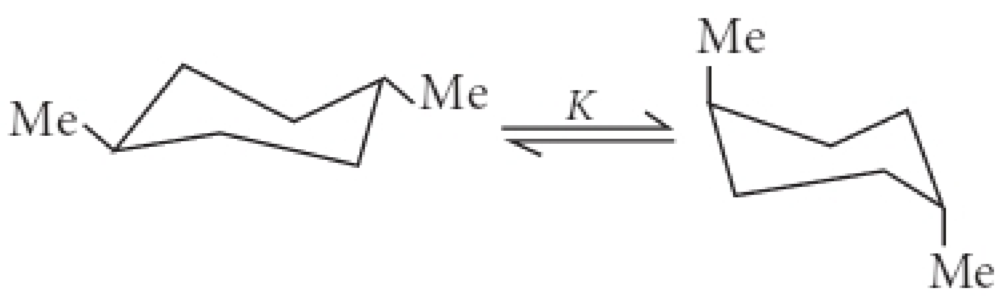


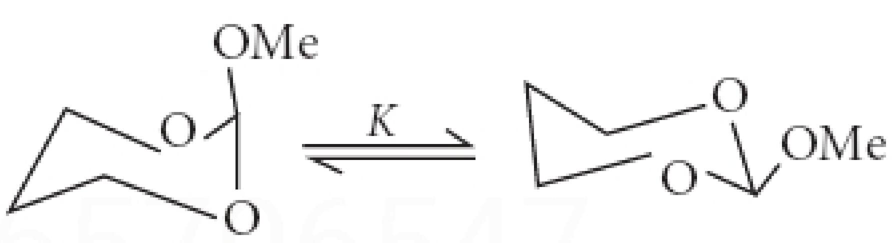
(d) 

6. Identify equilibrium which has maximum K (equilibrium constant)?

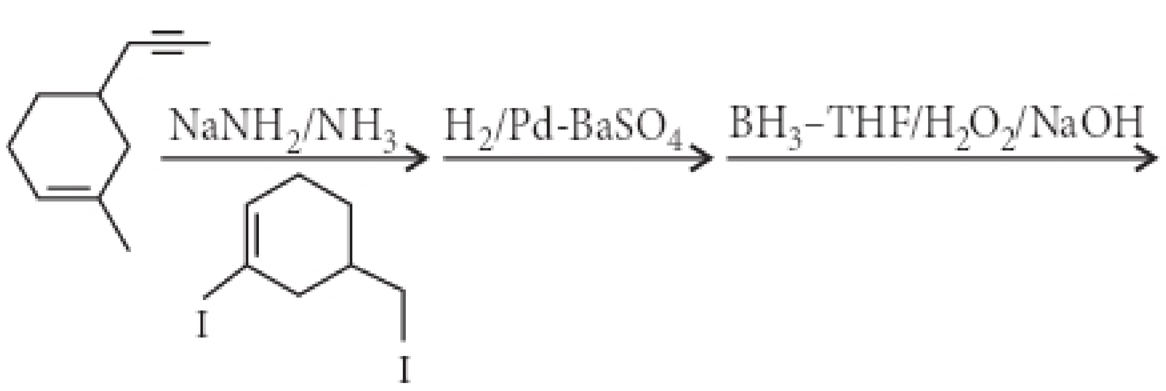
(a) 

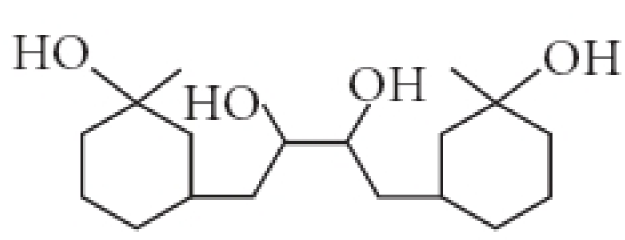
(b) 

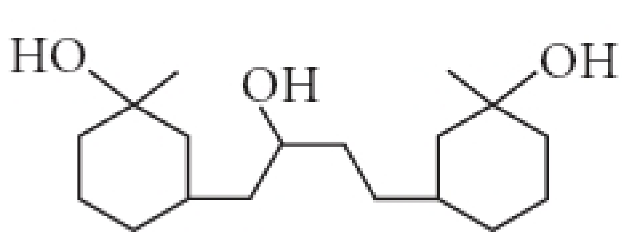
(c) 

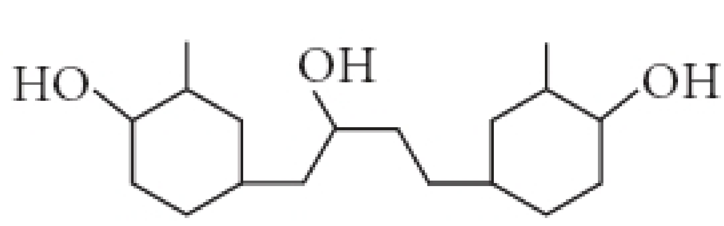
(d) 

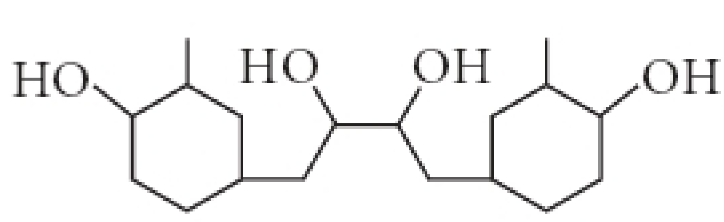
7. What is the product of the following sequence of reaction?



(a) 

(b) 

(c) 

(d) 

8. The correct order of O — O bond lengths in (I) O_2, (II) $O_2[AsF_4]$ and (III) KO_2 is

(a) III < II < I

(b) II < I < III

(c) III < I < II

(d) I < II < III.

9. Which of the following orders is not correct about bond angles?

(a) $SbCl_3 < SbBr_3 < SbI_3$

(b) $PI_3 > AsI_3 > SbI_3$

(c) $NO_2^+ > NO_2 > NO_2^-$

(d) $PF_3 < PCl_3 < PBr_3 < PI_3$

10. Which of the following pairs is isostructural?

(a) XeF_2 and IF_2^-

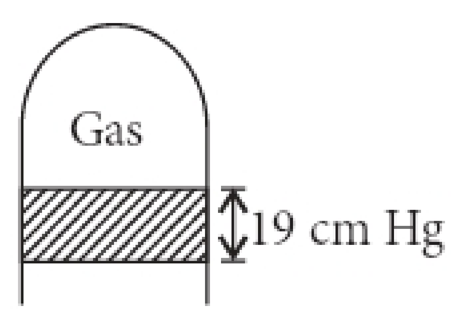
(b) NH_3 and BF_3

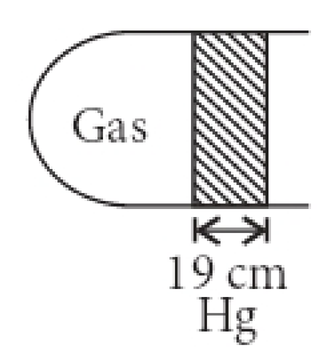
(c) CO_3^{2-} and SO_3^{2-}

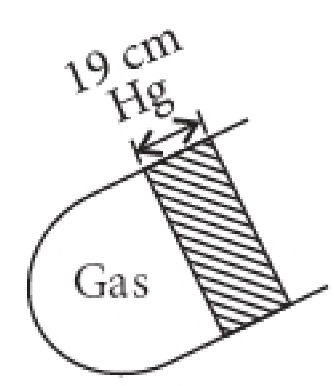
(d) PCl_5 and ICl_5

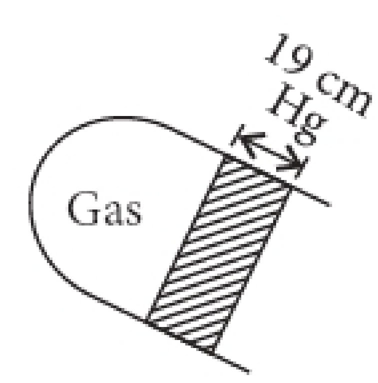
ONE OR MORE THAN ONE OPTIONS CORRECT

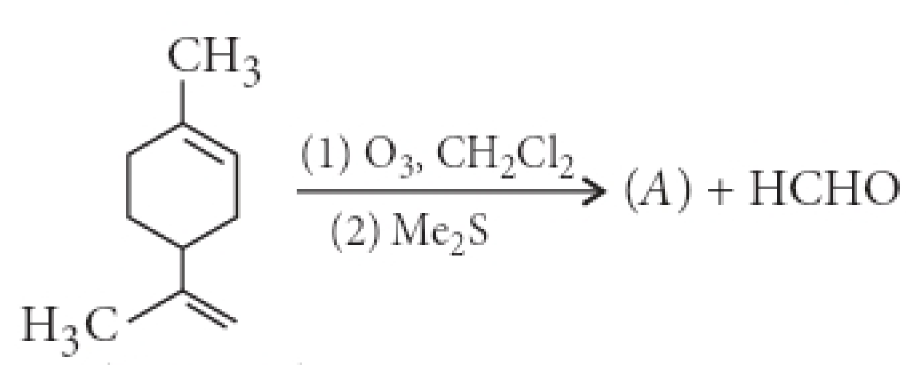
11. In which of the following cases, pressure of gas is less or equal to atmospheric pressure?

(a) 

(b) 

(c) 

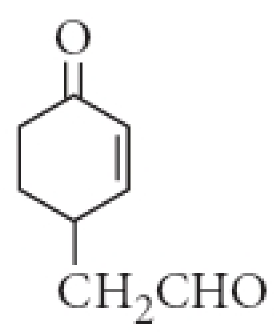
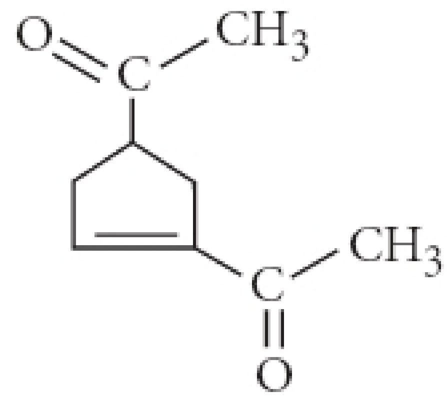
(d) 

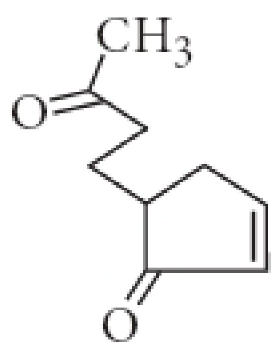
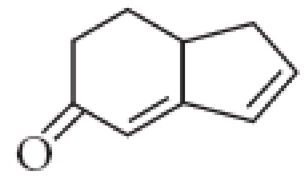
12. 

(Limonene)

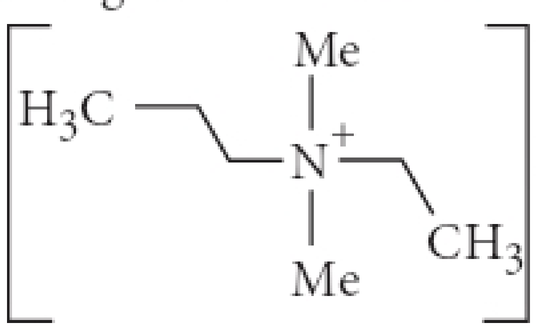
$(A) \xrightarrow[\Delta]{\text{dil. OH}^-}$ Products (mixture)

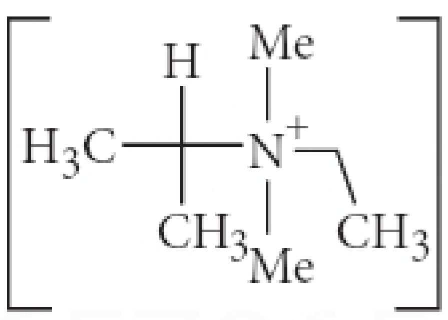
For the given reaction, the products are

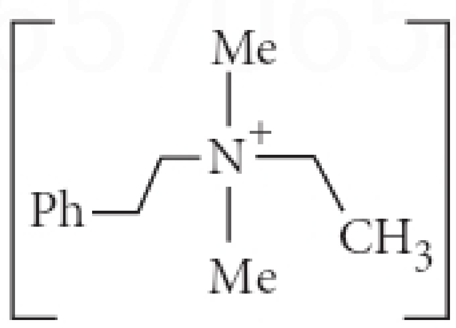
(a)  (b) 

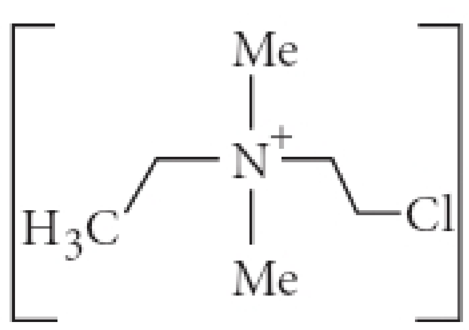
(c)  (d) 

13. Which of the following reactions is/are correct regarding the formation of major product (alkene)?

(a)  $OH^- \xrightarrow{\Delta} CH_2=CH_2$

(b)  $OH^- \xrightarrow{\Delta} CH_3-CH=CH_2$

(c)  $OH^- \xrightarrow{\Delta} Ph-CH=CH_2$

(d)  $OH^- \xrightarrow{\Delta} CH_2=CH-Cl$

SOLUTIONS

1. **(b) :** Radial node occurs where probability of finding the electrons is zero.

$\therefore \quad \psi^2 = 0, \psi = 0$

$27 - 18u + u^2 = 0 \quad \Rightarrow u = \frac{9 \pm 3\sqrt{3}}{2}$

$\Rightarrow \quad r = \frac{3a_0}{2Z}[3 \pm \sqrt{3}] = \frac{3}{4}(3 \pm \sqrt{3})\,a_0$

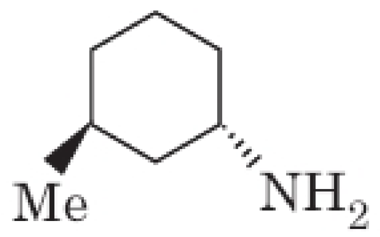
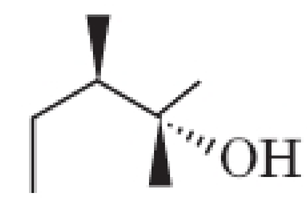
Thus, maximum radial distance, $r = \frac{3}{4}(3 + \sqrt{3})$

2. **(d) :** $E_n = -\frac{Rhc}{9}$, for $n = 3$

For single electron species, energy of $3s = 3p = 3d$.
So, degeneracy = 1 + 3 + 5 = 9

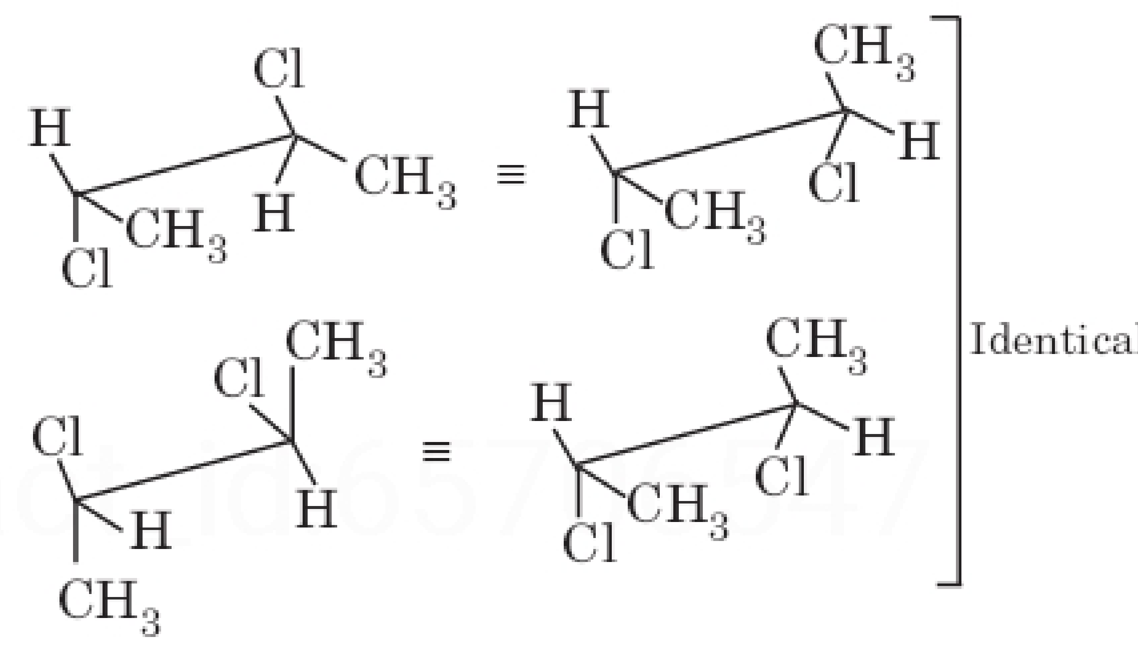
3. **(a) :** $\frac{1}{dU} \cdot \frac{dN}{N} = \frac{4}{\sqrt{\pi}}\left(\frac{M}{2RT}\right)^{1/2} \cdot e^{-1}$

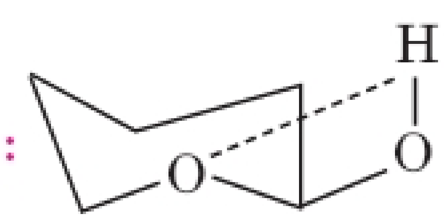
$dU = f\sqrt{\frac{2RT}{M}} \quad \therefore \quad \frac{dN}{N} = \frac{4f}{e\sqrt{\pi}}$

4. **(c) :**  

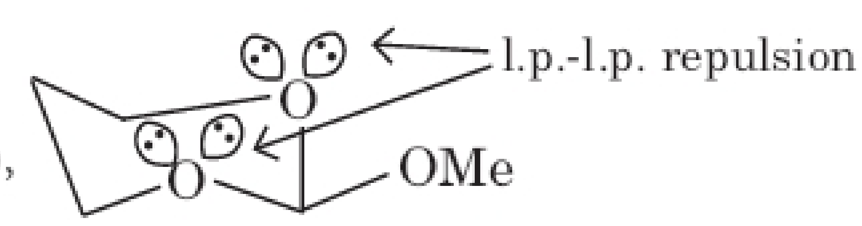
Absence of plane of symmetry and centre of symmetry — Absence of plane of symmetry and centre of symmetry

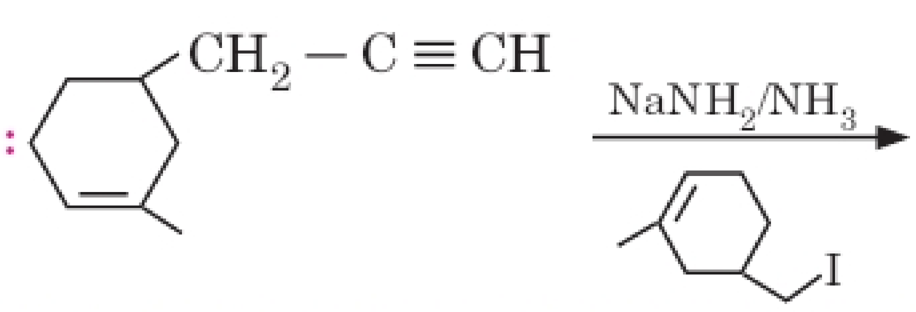
5. **(a) :**



6. **(b) :** 

H-bonding

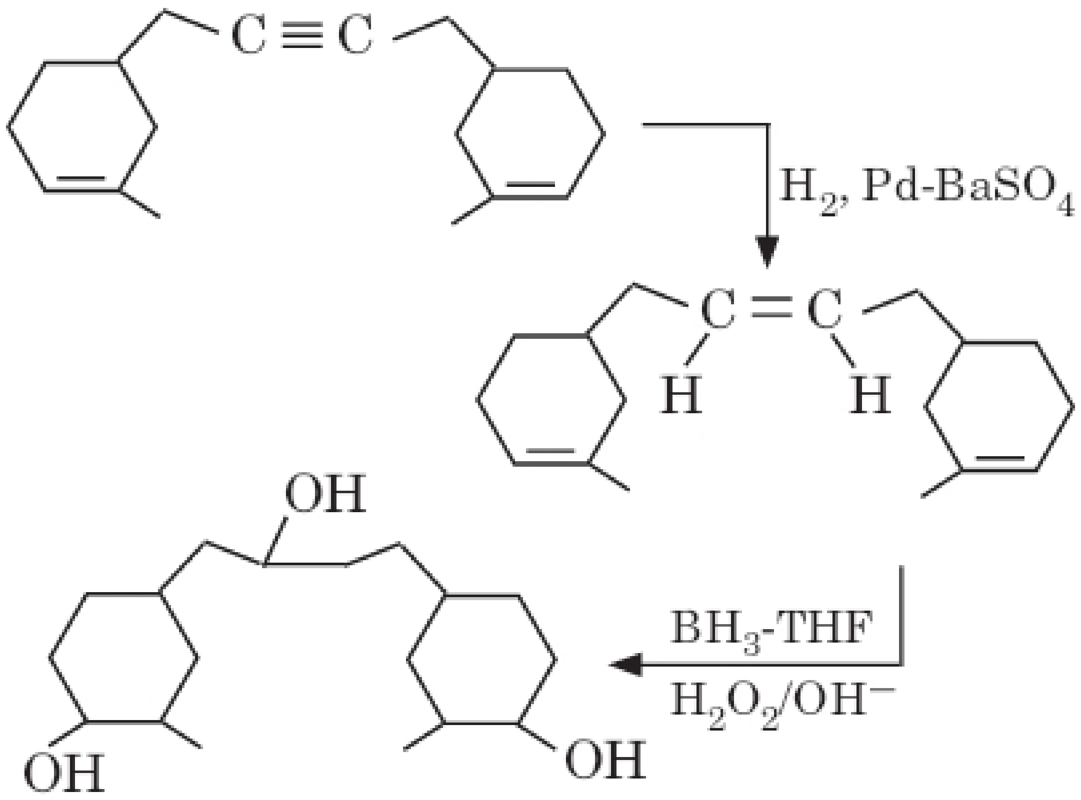
But in (d), 

7. **(c) :** 

Quotable Quote

"It takes nothing to join the crowd. It takes everything to stand alone."

HANS F. HANSEN

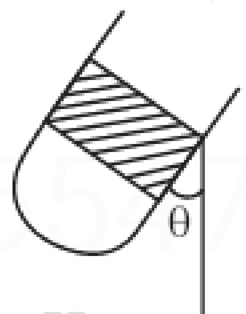


8. **(b) :** $O_2[AsF_4] \Rightarrow O_2^+ \Rightarrow$ bond order = 2.5
$K[O_2] \Rightarrow O_2^- \Rightarrow$ bond order = 1.5 and obviously bond order of O_2 = 2 and
bond length $\propto \dfrac{1}{\text{bond order}}$.

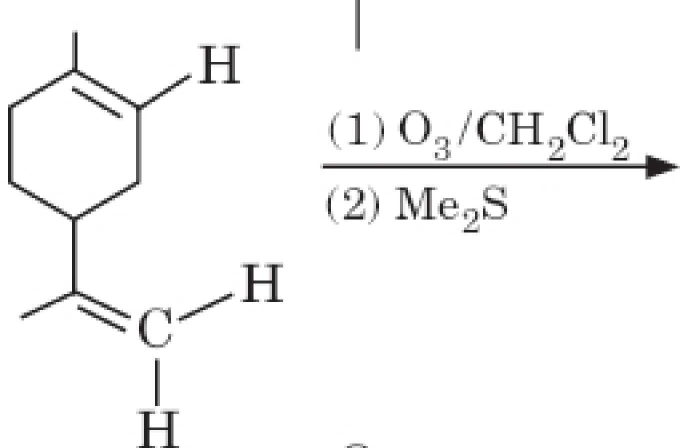
9. **(d) :** Bond angle of $PF_3 > PCl_3$ due to $p\pi$-$d\pi$ bonding.

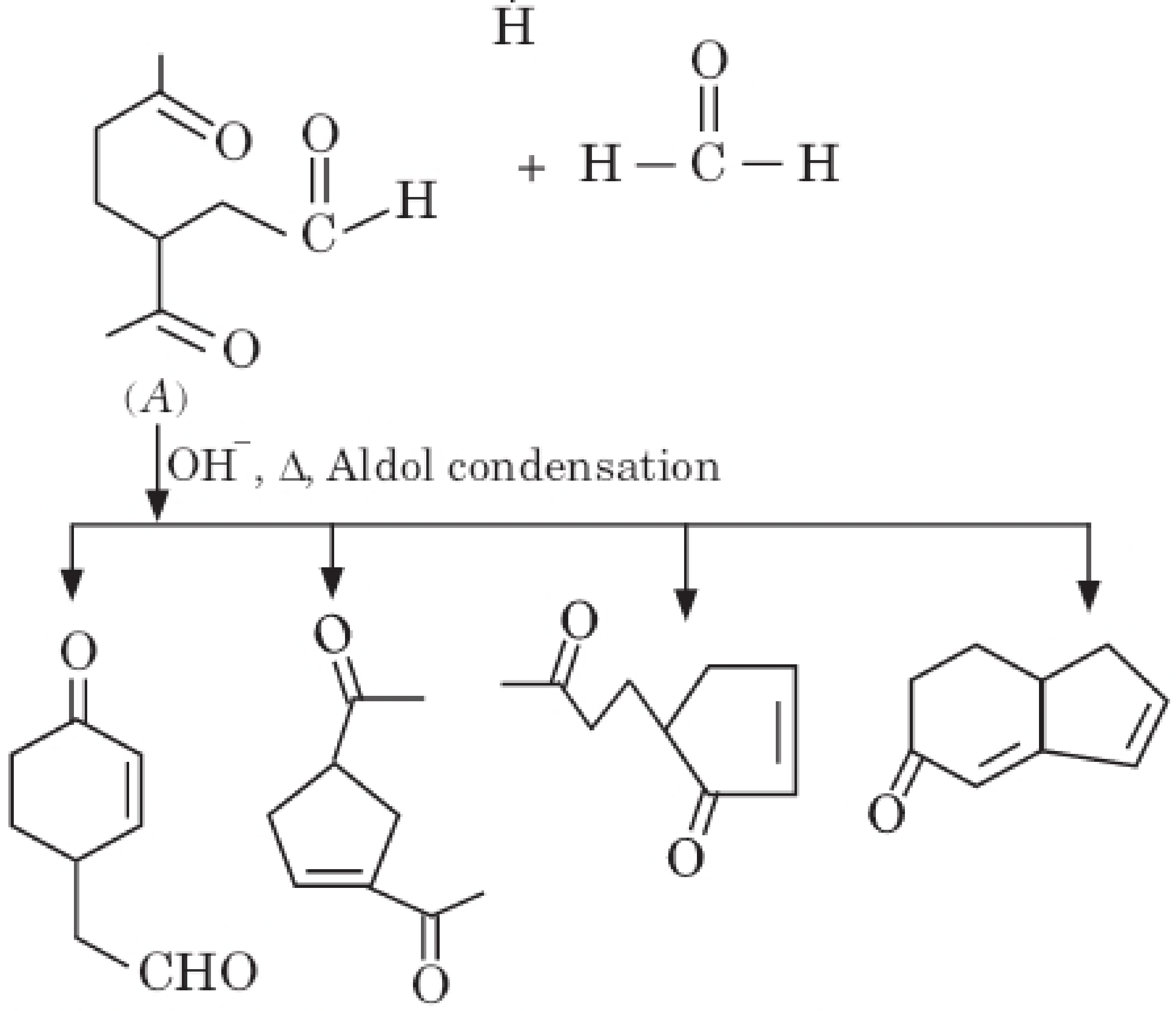
10. **(a) :** Both have sp^3d hybridisation with same electronic attributes.

11. **(a, b, d) :** $P_{gas} = 76 + 19\cos\theta > 1$



12. **(a, b, c, d) :**





13. **(a, b, c, d) :** Check carbanion stability.

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2 Focus on concepts

Aspirants should focus on concepts rather than adopting rote learning technique. Understanding helps you to remember the concepts for a very long period of time. Moreover, with a clear understanding of the concepts, you can comfortably handle questions related to these concepts.

3 Mix and match

Do not take up all easy subjects or topics in a day neither overburden yourself with topics that you find difficult. To maximise your output, start your "study day" with an easy or medium subject or topic for an hour or so, once you get warmed up, take up a difficult subject or topic.

4 Recall your syllabus at regular intervals

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CHEMISTRY MUSING

SOLUTION SET 79

1. **(a) :** $C_2H_6 + Br_2 \xrightarrow{\text{Monobromination}} C_2H_5Br$

$2C_2H_5Br + Na \xrightarrow[\text{Dry ether}]{\text{Wurtz reaction}} \underset{n\text{-butane}}{C_4H_{10}}$

Amount of n-butane to be produced = 55/58 mol

[mol. wt. of n-butane = 58]

= 0.948 mol

Amount of C_2H_5Br required to obtain 0.948 mol of $C_4H_{10} = 2 \times 0.948$ mol

$\therefore$ Amount of 85% C_2H_5Br required

$$= \frac{2 \times 0.948 \times 100}{85} \text{ mol}$$

Since one mol of C_2H_6 gives one mol of C_2H_5Br and % yield of monobromination is 90%, hence amount of C_2H_6 required

$$= \frac{2 \times 0.948 \times 100}{85 \times 90} \times 100 = 2.48 \text{ mol}$$

Volume of 2.48 mol of ethane at NTP

= 2.48 × 22.4 = 55.552 L

Hence, required volume of ethane = 55.552 L

2. **(c) :** $\underset{\substack{(A)\\ \text{(Black)}}}{MnO_2} + K_2CO_3 + \underset{\text{(Air)}}{1/2\, O_2} \xrightarrow{\Delta} \underset{\substack{(B)\\ \text{(Green)}}}{K_2MnO_4} + CO_2$

$$\underset{(B)}{2K_2MnO_4} + Cl_2 \rightarrow \underset{\substack{(C)\\ \text{Pink}}}{2KMnO_4} + 2KCl$$

3. **(a) :**

	N_2 +	PCl_5 ⇌	PCl_3 +	Cl_2
Mole at $t = 0$	1	3	0	0
Mole at equilibrium	1	$(3 - x)$	x	x

Total moles present at equilibrium = $4 + x$

Given, total pressure at equilibrium = 2.05 atm

Now, $PV = nRT$

$2.05 \times 100 = (4 + x) \times 0.0821 \times 500$

$x = 0.9939$

Now degree of dissociation of PCl_5

$$= \frac{\text{Mole dissociated}}{\text{Total moles}} = \frac{0.9939}{3} = 0.3313$$

$$\therefore \quad K_p = \frac{(p_{Cl_2}).(p_{PCl_3})}{(p_{PCl_5})}$$

$$p_{Cl_2} = \frac{x}{4+x}; p_{PCl_3} = \frac{x}{4+x}; p_{PCl_5} = \frac{(3-x)}{4+x}$$

$$K_p = \frac{\left(\frac{x}{4+x}\right)P \cdot \left(\frac{x}{4+x}\right)P}{\left(\frac{3-x}{4+x}\right)P} = \frac{x^2 \cdot P}{(3-x)\cdot(4+x)}$$

$$= \frac{(0.9939)^2 \times 2.05}{(3-0.9939)(4+0.9939)}$$

$K_p = 0.20$

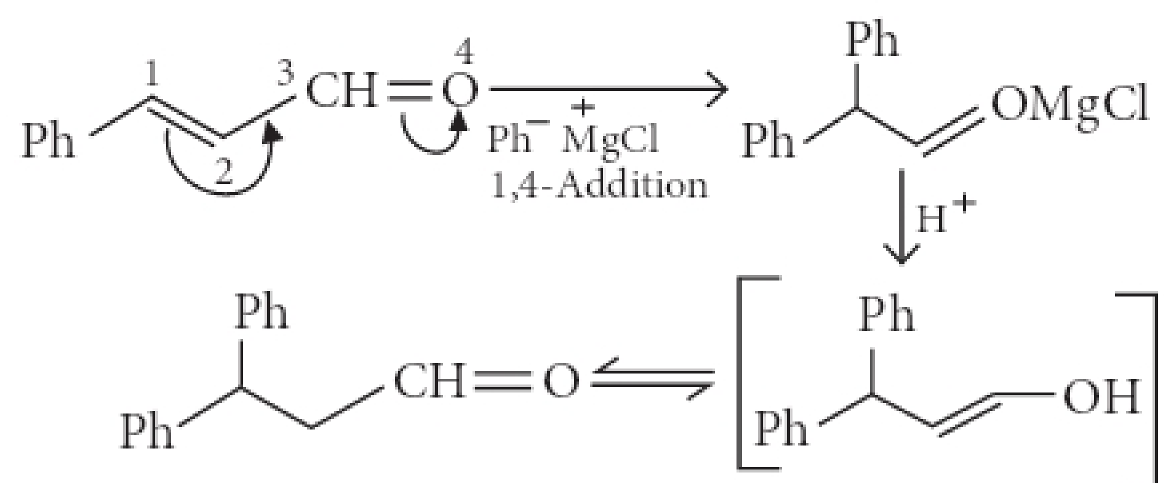
4. **(c) :** Since A when treated with $AgNO_3$ forms a white ppt (AgCl) which is readily soluble in dil. $NH_{3(aq.)}$ so A has atleast one ionisable chlorine atom. Moreover since the coordination number of chromium is 6 so the formula of the compound is $[Cr(NH_3)_4BrCl]Cl$.

Since compound B when treated with $AgNO_3$ forms a pale yellow ppt (AgBr) soluble in concentrated NH_3 so B has a ionisable bromine atom in the ionisation sphere. So the formula of B is $[Cr(NH_3)_4Cl_2]Br$. Cr in both A and B is in +3 oxidation state *i.e.*, Cr^{3+}.

Spin magnetic moment of A or B (n) = number of unpaired electrons = $\sqrt{n(n+2)}$

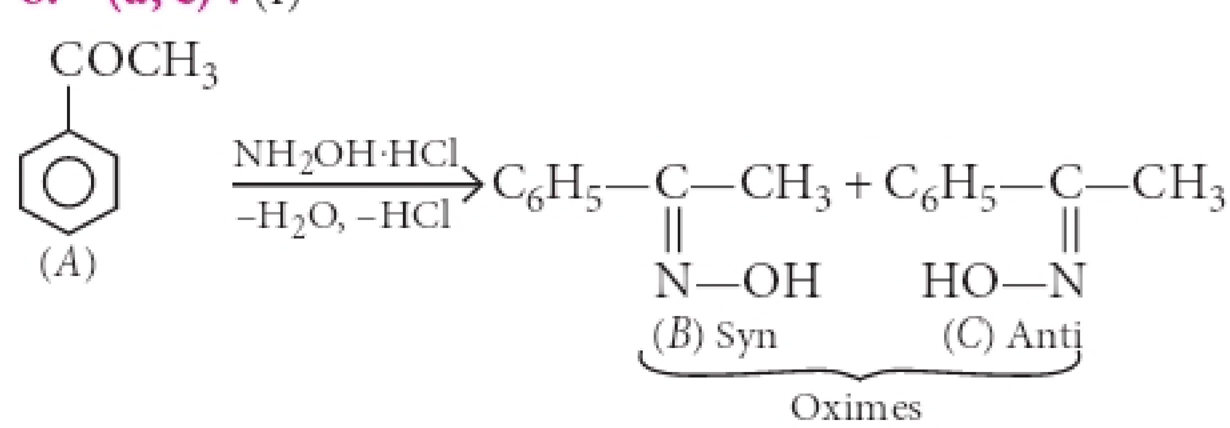
$= \sqrt{3(3+2)} = 3.87$ B.M.

5. **(a) :** For the explanation of reaction (a) and (b) : (C=O) is a stronger bond than (C=C), and thus the preferential addition is to (C=C). So (b) is correct.

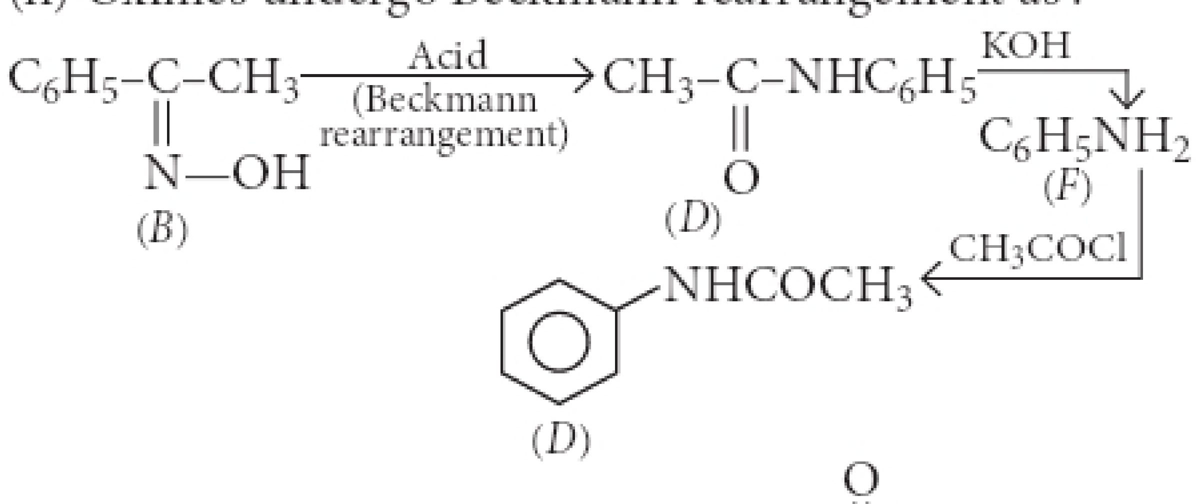


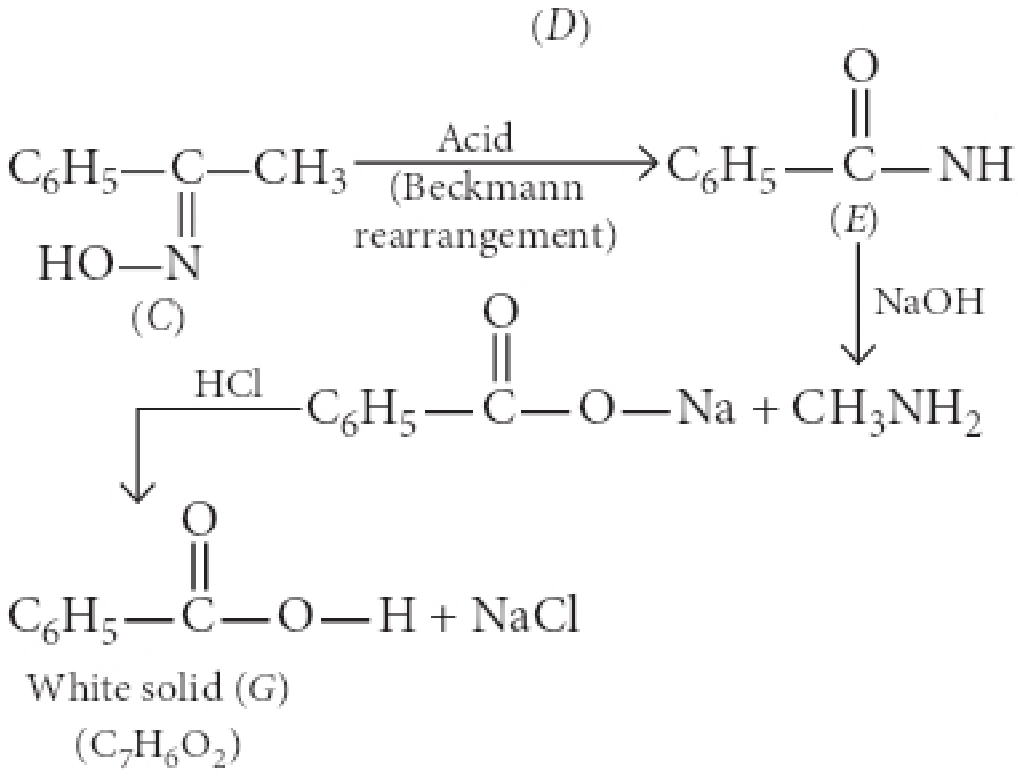
For reaction (d), due to steric hinderance and +I effect of three methyl groups, the reactivity of the (C=O) group is decreased, and hence the reaction occurs at (C=C) bond.

6. **(a, c) :** (i)



(ii) Oximes undergo Beckmann rearrangement as :





7. (c) : 1 mol ZnS gives 1 mol of ZnO

97 g ZnS gives 1 mol of ZnO

$225 \text{ kg ZnS} \equiv \frac{1 \text{ mol}}{0.97 \text{ kg}} \times 225 \text{ kg ZnO} = 2.3195 \text{ kmol of ZnO}$

$ZnO + 2NaOH \longrightarrow Na_2ZnO_2 + H_2O$

$\because$ 1 mol of ZnO dissolves in 2 mol of NaOH.

$\therefore$ 2.3195 kmol of ZnO dissolves in 2×2.3195 kmol of NaOH = 4.64 kmol of NaOH.

8. (none) : Molarity of 98% of H_2SO_4 by weight whose $\rho = 1.8$ g/mL can be calculated as follows :

1 mL H_2SO_4 contains = 1.8 g H_2SO_4

1000 mL H_2SO_4 contains = 1.8×10^3 g H_2SO_4

$$= \frac{1.8 \times 10^3}{98} H_2SO_4$$

i.e., Molarity of 100% H_2SO_4 = 18.36 M

Hence, molarity of 98% $H_2SO_4 = \frac{18.36}{100} \times 98 = 17.99$ M

In step (ii), 2.3195 kmol of ZnO is present.

1 mol of ZnO reacts with 1 mol of H_2SO_4.

Hence, 2.3195 kmol of ZnO needs 2.3195 kmol of H_2SO_4.

$\because$ 17.99 mol of H_2SO_4 are present in 1 L.

$\therefore$ 2.3195 kmol of H_2SO_4 are present in

$$\frac{1}{17.99} \times 2.3195 \times 10^3 \approx 130 \text{ L}$$

Note : None of the given option is correct.

9. (6.53) : Meq. of $HNO_3 = 5 \times 8 = 40$

Meq. of HCl = $4.8 \times 5 = 24$

Meq. of $H_2SO_4 = V \times 17 \times 2 = 34V$

(Let V mL of H_2SO_4)

$\therefore$ Total Meq. of acid in 2 litre solution

$= 40 + 24 + 34V = 64 + 34V$

Now Meq. of acid in 30 mL solution = Meq. of Na_2CO_3 used for it

$$= 42.9 \times \frac{1 \times 1000}{286/2 \times 100} = 3$$

$$\left(\because N_{Na_2CO_3} = \frac{1}{286/2} \times \frac{1000}{100}\right)$$

$\therefore$ Meq. of acid in 2 litre solution $\frac{3 \times 2000}{30} = 200$

$\therefore$ $64 + 34V = 200$

$\therefore$ $34V = 200 - 64 = 136$

Now Meq. of H_2SO_4 = Meq. of SO_4^{2-} = 34V = 136

$\therefore$ Meq. of $SO_4^{2-} = 136$

$\therefore$ $\frac{w}{96/2} \times 1000 = 136$

$\therefore$ weight of $SO_4^{2-} = 6.53$ g

10. (1.49) :

	$MnO_4^- + Fe^{2+} \longrightarrow$	$Mn^{2+} + Fe^{3+}$
Initial conc.	0.1 M	
Final conc.	$\frac{0.1 \times 10}{100}$	$\frac{0.1 \times 90}{100}$

$E_{cell} = E_{OP_H} + E_{RP_{MnO_4^-/Mn^{2+}}} = 0 + E_{RP_{MnO_4^-/Mn^{2+}}}$

The electrode reaction is

$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ (cathode)

$$\therefore \quad E_{RP} = E^\circ_{RP_{MnO_4^-/Mn^{2+}}} - \frac{0.059}{5} \log \frac{[Mn^{2+}]}{[MnO_4^-][H^+]^8}$$

$$= 1.51 - \frac{0.059}{5} \log \frac{\frac{0.1 \times 90}{100}}{\frac{0.1 \times 10}{100} \times (0.8)^8}$$

$= 1.51 - 0.02 = 1.49$ V

Monthly Test Drive CLASS XII ANSWER KEY

1. (a)	**2.** (a)	**3.** (c)	**4.** (a)	**5.** (a)
6. (a)	**7.** (c)	**8.** (a)	**9.** (a)	**10.** (c)
11. (a)	**12.** (b)	**13.** (a)	**14.** (a)	**15.** (c)
16. (d)	**17.** (a)	**18.** (b)	**19.** (b)	**20.** (b,c,d)
21. (a,b,c)	**22.** (b,d)	**23.** (a,c,d)	**24.** (3)	**25.** (4)
26. (0)	**27.** (a)	**28.** (d)	**29.** (b)	**30.** (c)


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